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GB

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CDH 75 M



CDV 75 M

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- DIN EN ISO 13849: PL e

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Benutzerhandbuch / User Manual

Absolute rotary encoder series CDx-75 with PROFIBUS-DP interface and PROFIsafe profile

- Grundlegende Sicherheitshinweise
- Verwendungszweck
- Allgemeine Funktionsbeschreibung
- Kenndaten
- Montage
- Installation/Inbetriebnahme
- Parametrierung
- Fehlerursachen und Abhilfen
- Basic safety instructions
- Proper use
- General functional description
- Characteristics
- Mounting
- Installation/Commissioning
- Parameterization
- Cause of faults and remedies



Translated Version

User Manual

CDx-75 PROFIBUS-DP/PROFIsafe

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Revision index

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- Extended temperature range of -20 to +70°C - Start-up torque – Shaft, in dependence of the temperature	05/25/11	03

1 General information

This Manual contains the following topics:

- General functional description
- Basic safety information with particulars of use
- Characteristics
- Assembly
- Installation/Commissioning
- Parameterization
- Error causes and remedies

As the documentation is arranged in a modular structure, the User Manual is supplementary to other documentation, such as product data sheets, dimensional drawings, brochures, etc.

The User Manual may be included in the customer's specific delivery package or it may be requested separately.

1.1 Applicability

This User Manual applies exclusively for the following measuring system series with **PROFIBUS-DP** interface and **PROFIsafe** profile:

- CDV-75
- CDH-75

The products are labeled with affixed nameplates and are components of a system.

The following documentation therefore also applies:

- operator's operating instructions specific to the system,
- and this User Manual

1.2 Applied directives and standards

The measuring systems in series CDx-75 have been developed, designed and manufactured taking account of the applicable European and international standards, directives and requirements.

Directives	
- 2004/108/EC (L 390/24)	EMC Directive
- 2006/42/EC (L 157/24)	Machinery Directive
EMC; Immunity to disturbance according to EN 61000-6-2:2005, industrial environments:	
- DIN EN 61000-4-2:2009	Electrostatic discharge, ESD
- DIN EN 61000-4-3:2008	Radio-frequency electromagnetic fields
- DIN EN 61000-4-4:2005	Fast transient electrical disturbances, burst
- DIN EN 61000-4-5:2007	Surge
- DIN EN 61000-4-6:2009	Immunity to conducted disturbances, induced by radio-frequency fields
- DIN EN 61000-4-8:2009	Power frequency magnetic fields
- VDE 0847-4-3:2008	Interference caused by mobile communications
EMC; Transient emissions according to EN 61000-6-3:2007, residential environments:	
- EN 55022:2006	Disturbance field strength, 30 MHz - 1 GHz
- EN 55022:2006	Interference current, < 30 MHz
- DIN EN 62061:2005 Appendix F	Electromagnetic phenomena and increased levels of immunity to disturbance for SRECS, which are intended for use in industrial environments in accordance with IEC61000-6-2
- DIN EN 61326-3-2:2008	Immunity to disturbance requirements for safety-related systems and for devices
Safety	
- DIN EN 61508 Part 1-7:2010	Functional safety
- EN 61800-5-2:2007	Adjustable speed electrical power drive systems; Safety requirements - Functional
- EN 60204-1:2006	Safety of machinery - Electrical equipment of machines - Part 1: General requirements
- EN 62061:2005, Appendix E	Safety of machinery - Functional safety of safety-related E/E/PE control systems
- EN ISO 13849-1:2008/AC:2009	Safety of machinery - Safety-related parts of control systems
Environmental influences	
- DIN EN 60068-2-6:2008	Vibration (sinusoidal)
- DIN EN 60068-2-64:2009	Broadband random
- DIN EN 60068-2-27:2010	Single shock
- DIN EN 60068-2-1:2008	Cold
- DIN EN 60068-2-2:2008	Dry heat
GS - ET - 26, Certification of bus systems	
Final draft by Electrotechnical Expert Committee for the inspection and certification of:	"Bus systems for the transmission of safety-relevant messages"

1.3 General functional description

The CDx-75 rotary measuring system is a safe and absolute Multi-Turn position measuring system with PROFIBUS interface and PROFIsafe protocol.

The measuring system has primarily been designed for use in systems that require safe position detection.

The safety measuring system consists of a **redundant, two-channel system**, in which **optical** and **magnetic scanning units** are arranged on a drive shaft, designed as a hollow shaft or solid shaft.

1.3.1 Main features

- PROFIBUS interface with PROFIsafe protocol, for transfer of a safe position and speed
- Quick process data channel via PROFIBUS, not safety-oriented
- Additional SIN/COS or incremental interface, not safety-oriented
- Two-channel scanning system, for generation of safe measured data through internal channel comparison
 - Channel 1, master system:
optical Single-Turn scanning via code disk with transmitted light and magnetic Multi-Turn scanning
 - Channel 2, inspection system:
magnetic Single and Multi-Turn scanning
- A common drive shaft

Due to its technology the optical system possesses greater accuracy, therefore it is used as master system. The data of the master system are unevaluated in the non-safety-oriented process data channel with normal PROFIBUS protocol, but are made available with a short cycle time.

The magnetic scanning system serves for the internal safety check. The "safe data" obtained through two-channel data comparison are packed into the PROFIsafe protocol and also transmitted to the control via the PROFIBUS.

The SIN/COS interface, or the optionally available incremental interface, is derived from the master system and is not evaluated in relation to safety.

1.3.2 Principle of the safety function

System safety results when:

- Each of the two scanning channels is largely fail-safe thanks to individual diagnostic measures
- The measuring system internally compares the positions detected by both channels in two channels, also determines the speed in two channels and transfers the safe data to the PROFIBUS in the PROFIsafe protocol, see Figure 1 "Black Channel" on page 116
- In the event of a failed channel comparison or other errors detected through internal diagnostic mechanisms, the measuring system switches the PROFIsafe channel into error state
- The measuring system initialization and execution of the preset adjustment function are appropriately verified
- The control additionally checks whether the obtained position data lie in the position window expected by the control. Unexpected position data are e.g. position jumps, tracking error deviations and incorrect direction of travel
- When errors are detected the control introduces appropriate safety measures defined by the system manufacturer
- The system manufacturer ensures, through correct mounting of the measuring system, that the measuring system is always driven by the axis for measurement
- The system manufacturer performs a verified test during commissioning and in the event of any parameter modification

1.4 Overview of the complete system

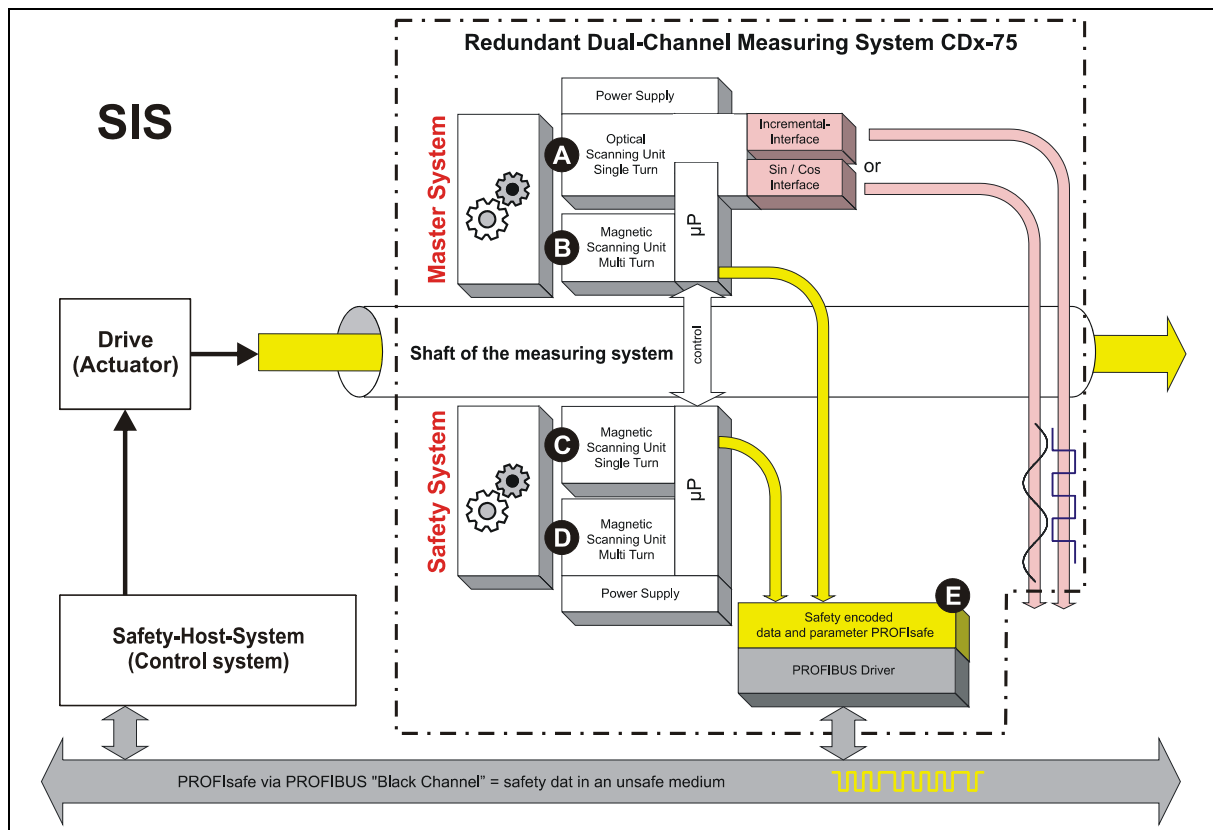


Figure 1: System diagram

A Master system, Single-Turn

- Optical detection of number of steps/revolution
- max. 8192 steps/revolution with 13 bit accuracy
- SIN/COS signals for position feedback, incremental signals also optionally possible

B Master system, Multi-Turn

- Magnetic detection of the number of revolutions
- max. 32768 revolutions

C Inspection system, Single-Turn

- Magnetic detection of number of steps/revolution
- max. 8192 steps/revolution with 8 bit accuracy

D Inspection system, Multi-Turn

- Magnetic detection of the number of revolutions
- max. 32768 revolutions

E Channel comparison, speed generation and bus handling

- Position comparison of the master in the parameterized position window of the test channel
- Generation of speed depending on the parameterized integration time
- Generation of PROFIBUS-DP and PROFIsafe telegrams

2 Basic safety instructions

2.1 Definition of symbols and notes



means that death or serious injury will occur if the required precautions are not met.



means that death or serious injury can occur if the required precautions are not met.



means that minor injuries can occur if the required precautions are not met.

NOTICE

means that damage to property can occur if the required precautions are not met.



indicates important information or features and application tips for the product used.



means that appropriate protective measures against ESD according to DIN EN 100 015-1 must be applied.

(Equalizing the potential between the body and both the equipment ground and the housing ground by means of a high resistance (ca. 1 MOhm) e.g. with a commercially available ESD armband).

2.2 General risks when using the product

The product, hereinafter referred to as ***the measuring system***, is manufactured according to state-of-the-art technology and accepted safety rules. ***Nevertheless, improper use can pose a danger to life and limb of the user or third parties, or lead to impairment of the measuring system or other property!***

Only use the measuring system in perfect technical condition, paying attention to safety and dangers, and in compliance with the ***User Manual!*** Faults which could threaten safety should be eliminated without delay!

2.3 Intended use

The safety measuring system can be used for the detection of angular movement and processing of measured data for a downstream safety host (F-Host) in systems in which the **goal of "Protection of travel"** must be safely achieved. The complete processing chain of the safety function must then satisfy the requirements of the applied safety standard.

The safety measuring system must only be used in safety applications in conjunction with a control certified according to the applied safety standard.

The system manufacturer must check that the characteristics of the measuring system satisfy his application-specific safety requirements. The responsibility or decision regarding the use of the measuring system lies with the system manufacturer.

Proper use also includes:

- observing all instructions in this User Manual,
- observing the nameplate and any prohibition or instruction symbols on the measuring system,
- observing the enclosed documentation, e.g. product insert, connector configuration etc.
- observing the operating instructions from the machine/system manufacturer,
- operating the measuring system within the limit values specified in the technical data,
- ensuring that the fail-safe processing unit (F-Host) fulfils all required safety functions,
- observing and using the checklist in the Appendix,
- safe mounting of the measuring system to the driving axis

The following areas of use are especially forbidden:

- in environments where there is an explosive atmosphere,
- for medical purposes,

2.4 Safety functions of the fail-safe processing unit

The **F-Host**, to which the measuring system is connected, must perform the following safety checks.

To enable the correct measures to be taken in case of measure, the following applies:

If no safe position can be output due to an error detected by the measuring system, the PROFIsafe data channel is automatically put into fail-safe status. In this status so-called "passivated data" are output via PROFIsafe. Also see the chapter "Output of passivated data (substitute values) in case of error" on page 183.

Passivated data are:



- PROFIsafe data channel: all outputs are set to 0
- PROFIsafe status: error bit 2¹ Device_Fault is set
- PROFIsafe-CRC: valid

Upon receipt of passivated data, the F-Host must put the system into a safe state. It is only possible to leave this error state by eliminating the error and then switching the supply voltage off and on again!

The process data channel addressable via PROFIBUS is not necessarily affected by this. If the internal diagnosis in the master channel does not detect an error, the process data are still output. However, these data are not safe for the purposes of a safety standard.

2.4.1 Mandatory safety checks / measures

Measures for commissioning, changes	F-Host error reaction
Application-dependent parameterization and definition of the necessary iParameters, see chapter "iParameters" on page 159.	–
In the event of parameter changes, check that the measure is executed as desired.	STOP

Check by F-Host	F-Host error reaction
Cyclical consistency check of the current safety-oriented data in the TR-PROFIsafe module in relation to the previous data.	STOP
Travel curve calculation and monitoring by means of cyclical data in the TR-PROFIsafe module.	STOP
Monitoring of cyclical data in the TR-PROFIsafe module, and the process data in the TR-PROFIBUS module.	Receipt of passivated data --> STOP
Timeout: Monitoring of the measuring system - response time. For checking e.g. cable breakage, power failure etc.	STOP

2.5 Warranty and liability

In principle the "General Terms and Conditions" of TR-Electronic GmbH apply. These are available to the operator with the Order Confirmation or when the contract is concluded at the latest. Warranty and liability claims in the case of personal injury or damage to property are excluded if they result from one or more of the following causes:

- Non-designated use of the measuring system.
- Improper assembly, installation, start-up and programming of the measuring system.
- Work carried out incorrectly on the measuring system
- Operation of the measuring system with technical defects.
- Mechanical or electrical modifications to the measuring systems undertaken autonomously.
- Repairs carried out autonomously.
- Third party interference and Acts of God.

2.6 Organizational measures

- The User Manual must always be kept ready-to-hand at the place of use of the measuring system.
- In addition to the User Manual, generally valid legal and other binding regulations on accident prevention and environmental protection must be observed and communicated.
- The respective applicable national, local and system-specific provisions and requirements must be observed and communicated.
- The operator is obliged to inform personnel on special operating features and requirements.
- Prior to commencing work, personnel working with the measuring system must have read and understood the chapter "Basic safety instructions".
- The nameplate and any prohibition or instruction symbols applied on the measuring system must always be maintained in a legible state.
- Do not undertake any mechanical or electrical modifications to the measuring system, except for those expressly described in this User Manual.
- Repairs may only be undertaken by the manufacturer or a center or person authorized by the manufacturer.

2.7 Personnel selection and qualification; basic obligations

- All work on the measuring system must only be carried out by qualified personnel. Qualified personnel includes persons, who, through their training, experience and instruction, as well as their knowledge of the relevant standards, provisions, accident prevention regulations and operating conditions, have been authorized by the persons responsible for the system to carry out the required work and are able to recognize and avoid potential hazards. They are capable of identifying and avoiding potential hazards.
- The definition of "qualified personnel" also includes an understanding of the standards VDE 0105-100 and IEC 364 (source: e.g. Beuth Verlag GmbH, VDE-Verlag GmbH).
- The responsibility for assembly, installation, commissioning and operation must be clearly defined. The obligation exists to provide supervision for trainee personnel.

2.8 Safety information

- **Destruction, damage and malfunction of the measuring system!**

- Only carry out wiring work or opening and closing of electrical connections with the system de-energized.
- Do not undertake any welding work if the measuring system is already wired or switched on.
- Falling below or exceeding the permissible ambient temperature limit values must be prevented through an appropriate heating/cooling measure at the place of installation.
- The measuring system must be installed so that no direct moisture can affect the measuring system.
- Suitable aeration/ventilation and heating/cooling measures must be provided at the place of installation to prevent the temperature falling below the dew point (condensation).

⚠ WARNING

- If an overvoltage of >36 V DC is inadvertently applied the measuring system must be inspected in the factory, with specification of the reasons or circumstances.

NOTICE

- Potential hazards resulting from interactions with other systems and equipment which are or will be installed in the vicinity must be checked. The user is responsible for taking appropriate measures.
- The power supply must be protected with a fuse suitable for the supply lead cross-section.
- Cables used must be suitable for the temperature range.
- A defective measuring system must not be operated.
- Make sure that the installation environment is protected from aggressive media (acids etc.).
- Avoid shocks (e.g. hammer blows) to the shaft during installation.
- Opening the measuring system is forbidden.
- The type plate specifies the technical characteristics of the measuring system. If the type plate is no longer legible or if the type plate is completely missing, the measuring system must not be operated.



- **The measuring system contains components and assemblies susceptible to electrical discharge, which can be destroyed if incorrectly handled.**
 - Touching the measuring system connection contacts with the fingers must be avoided or the relevant ESD protective measures must be applied.
-



- **Disposal**
 - If disposal has to be undertaken after the lifespan of the device, the respective applicable country-specific regulations are to be observed.
-

3 Transport / Storage

- **Shipping information**
 - Do not drop the device or subject it to heavy impacts!
The device contains an optical system.
 - Use only the original packaging.
Inappropriate packaging material may cause damage to the unit in transit.

- **Storage**
 - Storage temperature: -30 to +80°C
 - Store in a dry place

4 Assembly

4.1 Solid shaft version CDV-75

The measuring system is connected to the drive shaft by an elastic coupling. Axial and radial deviations between the measuring system and the drive shaft are absorbed by the coupling. This prevents excessive bearing loads.

The centering collar with appropriate fit ensures centering in relation to the shaft. Fixing to the machine is made by means of three screws in the flange.

All fastening screws must be secured against unintentional loosening.

4.1.1 Requirements

- **Danger of death, serious physical injury and/or damage to property due to deactivation of safety functions, caused by an unstable shaft drive!**
 - The system manufacturer must implement suitable design measures, so that the drive of the measuring system is ensured at all times through the shaft and mounting of the measuring system (fault exclusion). The specifications of DIN EN 61800-5-2:2008 "Adjustable speed electrical power drive systems, Safety requirements - Functional, Table D.16 – Motion and position sensors" must be observed.
 - In general, the requirements and acceptance conditions for the complete system must be taken into account for mounting.

As the installation situation is application-dependent, the following notes are not exhaustive.

 **DANGER**

NOTICE

- A suitable coupling with positive connection must be used for the application.
- The coupling manufacturer's information and installation requirements must be observed.
- In particular, you must ensure that
 - the coupling is suitable for the specified speed and the potential axial offset,
 - installation is on a grease-free shaft,
 - the coupling and the measuring system are not axially loaded,
 - the clamping screws are tightened with the torque defined by the coupling manufacturer,
 - the coupling screws are secured against unintentional loosening.
- Axial slipping of the measuring system on the drive shaft must be prevented by the coupling fixing, see Figure 2, **1**.
- Radial slipping of the measuring system on the drive shaft must be prevented by means of form closure, using a parallel key / groove combination (Figure 2, **2**); a coupling with groove must be used for this purpose.
- In case of applications with low ambient temperatures, increased values for the start-up torque result. This fact is to be considered when the assembling and wave drive is performed.

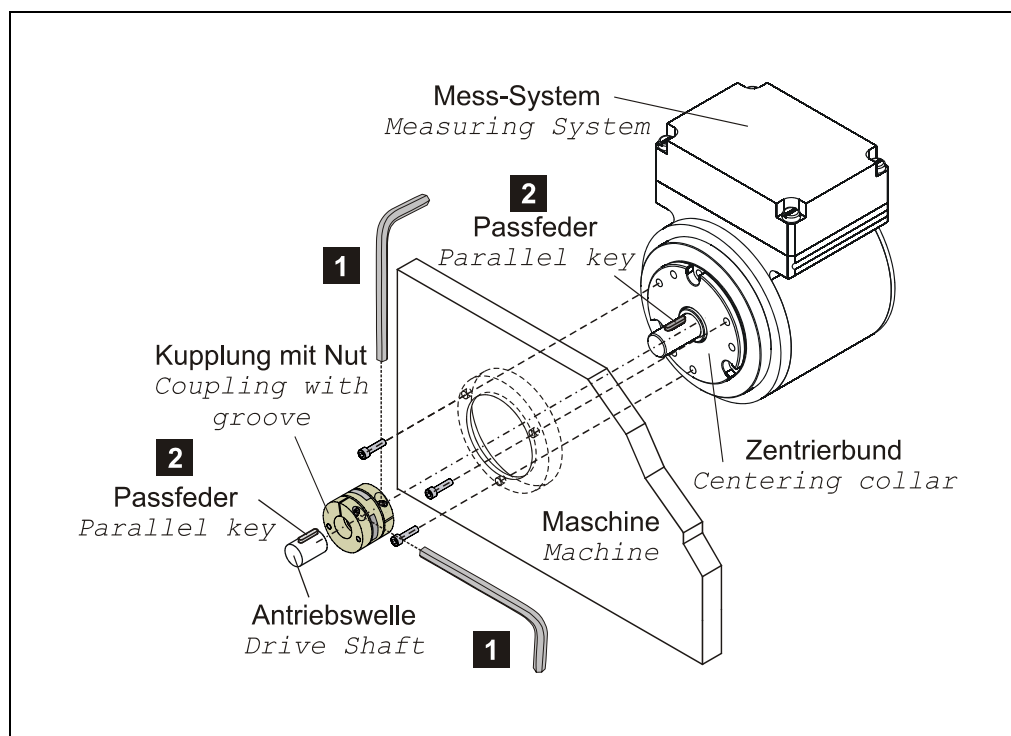


Figure 2: Flange installation

4.1.2 Start-up torque of the shaft, in dependence of the temperature

Temperature [°C]	Radius [cm]	Force [N]	Start-up torque [Ncm]
25	1.5	0.5	0.75
-20	1.5	1.5	2.25
-40	1.5	6.7	10.05

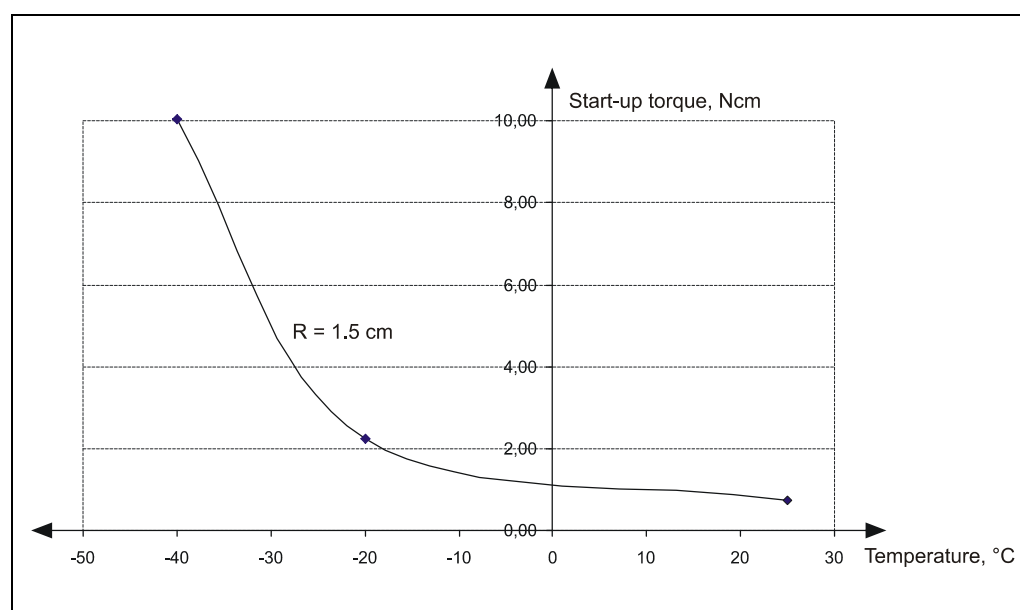


Figure 3: Start-up torque

4.2 Hollow shaft version CDH-75

4.2.1 Requirements

- **Danger of death, serious physical injury and/or damage to property due to deactivation of safety functions, caused by an unstable shaft drive!**
 - The system manufacturer must implement suitable design measures, so that the drive of the measuring system is ensured at all times through the shaft and mounting of the measuring system (fault exclusion). The specifications of DIN EN 61800-5-2:2008 "Adjustable speed electrical power drive systems, Safety requirements - Functional, Table D.16 – Motion and position sensors" must be observed.
 - In general, the requirements and acceptance conditions for the complete system must be taken into account for mounting.

As the installation situation is application-dependent, the following notes are not exhaustive.

 **DANGER**

NOTICE

- The measuring system must be installed on a grease-free shaft.
- Axial slipping of the measuring system on the drive shaft must be prevented by the fixing of the clamping ring, see Figure 4.
- Further measures may be required to prevent axial slipping of the measuring system.
- The clamping of the measuring system must not be axially loaded.
- The screw of the clamping ring must be tightened with 3 Nm using a torque wrench.
- The screw must be secured against unintentional loosening.
- Radial slipping of the measuring system on the drive shaft must be prevented by means of form closure, using a parallel key / groove combination; the measuring system must be fixed on the side of the drive using a dowel pin, see Figure 5.
- In case of applications with low ambient temperatures, increased values for the start-up torque result. This fact is to be considered when the assembling and wave drive is performed.

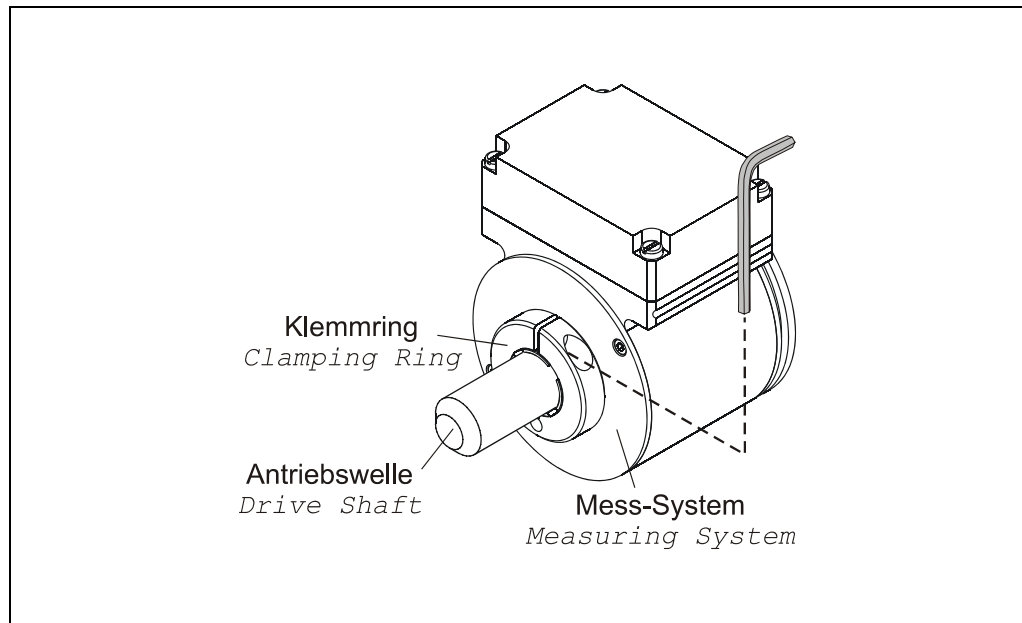


Figure 4: Friction locking

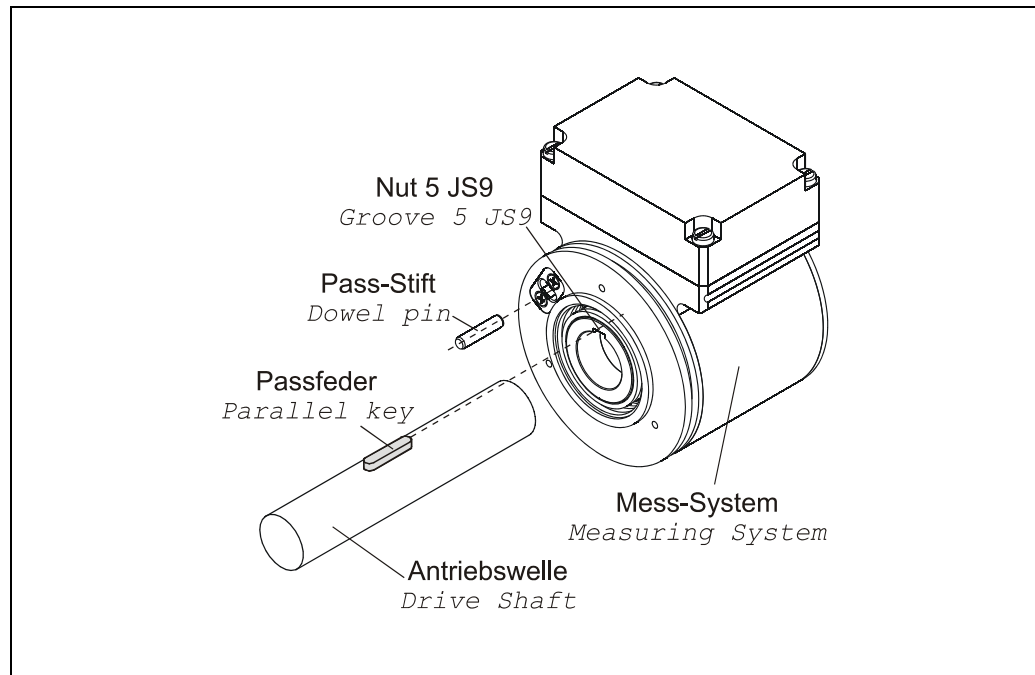


Figure 5: Form closure

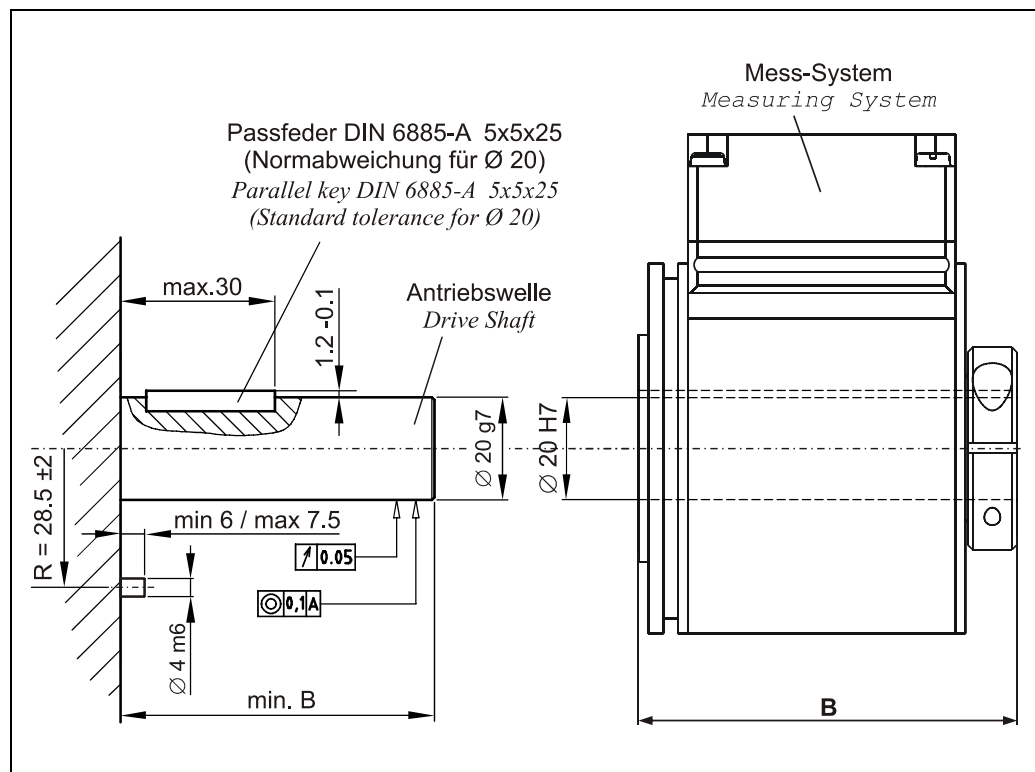


Figure 6: Requirements for the shaft mounting

4.2.2 Dowel pin

Simultaneous rotation of the measuring system, caused by the developing torque, is prevented by a dowel pin on the machine side. The measuring system has a groove insertion 4K7, 6mm deep on the back, for mounting the dowel pin. The dowel pin must extend at least 4 mm into the groove insertion.

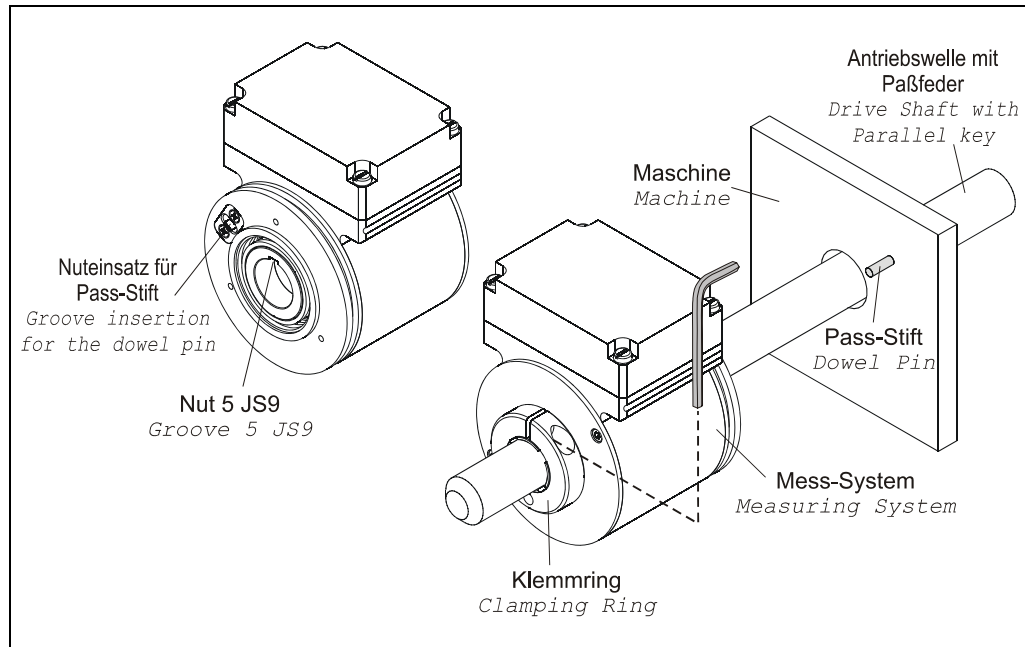


Figure 7: Preventing simultaneous rotation using a dowel pin

When pushing on the measuring system, position it so that the dowel pin fits into the seat of the groove insertion. The measuring system is protected against slipping on the shaft by tightening the clamping ring with the Allen wrench.

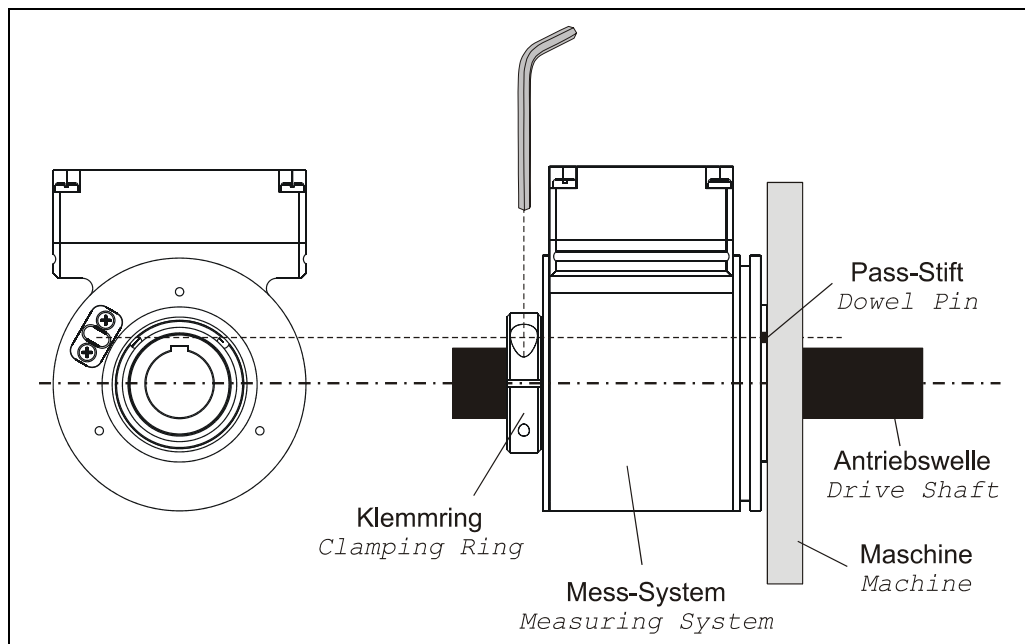


Figure 8: Installation diagram

5 Installation / Preparation for Commissioning

5.1 Basic rules

WARNING

Deactivation of the safety function through conducted interference sources!

- All devices, standards and safety functions used on the bus must have a PROFIBUS certificate or a corresponding manufacturer's declaration.
- All safety devices must also have a certificate from a "Notified Body" (e.g. TÜV, BIA, HSE, INRS, UL, etc.).
- The 24V power supplies used must not cut out in the event of a fault in the energy supply (safe under single fault conditions) and must fulfil SELV/PELV.
- No stub lines.
- The shielding effect of cables must also be guaranteed after installation (bending radii!) and after connector changes. In cases of doubt, use more flexible cables with a higher current carrying capacity.
- Only use M12 connectors for connecting the measuring system, which guarantee good contact between the cable shield and connector housing. The cable shield must be connected to the connector housing over a large area.
- A 5-wire cable with a PE-conductor isolated from the N-conductor (so-called TN network) must be used for the drive/motor cabling. This will largely prevent equipotential bonding currents and the development of interference.
- A shielded and stranded data cable must be used to ensure high electromagnetic interference stability of the system. The shielding should be connected with low resistance to protective ground using large shield clips at **both ends**. The shielding should be grounded **in the switch cabinet only** if the machine ground is heavily contaminated with interference towards the switch cabinet ground.
- Equipotential bonding measures must be provided for the complete processing chain of the system.
- Power and signal cables must be laid separately.
- Observe the manufacturer's instructions for the installation of converters and for shielding power cables between frequency converter and motor.
- Ensure adequate dimensioning of the energy supply.

Upon completion of installation, a visual inspection with report should be carried out. Wherever possible, the quality of the network should be verified using a suitable bus analysis tool: no duplicate bus addresses, no reflections, no telegram repetitions etc.



To ensure safe and fault-free operation, the

- IEC 61918 "Installation of communication networks in industrial premises"
- IEC 61784-5-3 "Installation profiles for CPF 3"
- PROFIBUS Assembly Guideline, Order no.: 8.022
- PROFIBUS Commissioning Guideline, Order no.: 8.032
- PROFIsafe "Environmental Requirements", Order no.: 2.232
- and other pertinent standards and directives must be observed!

In particular the EMC directive in its valid versions must be observed!

5.2 PROFIBUS transfer technology, cable specification

All devices are connected in a bus structure (line). Up to 32 clients (master or slaves) can be connected together in a segment.

The bus is terminated with an active bus termination at the beginning and end of each segment. For stable operation, it must be ensured that both bus terminations are always supplied with voltage. The bus termination must be provided externally via the connection plug.

Repeaters (signal amplifiers) have to be used with more than 32 clients or to expand the network scope in order to connect the various bus segments.

All cables used must conform with PROFIBUS specifications for the following copper data cable parameters:

Parameter	Cable type A
Wave impedance in Ω	135...165 at a frequency of 3...20 MHz
Operating capacitance (pF/m)	30
Loop resistance (Ω /km)	≤ 110
Wire diameter (mm)	> 0.64
Wire cross-section (mm ²)	> 0.34
Shielding	Generally foil shielding with braided shield

The transmission speed for PROFIBUS is selectable in the range between 9.6 kBit/s and 12 Mbit/s and is automatically detected by the measuring system. It is selected for all devices on the bus at the time of commissioning the system.

The range is dependent on the transmission speed for cable type A:

Baud rate (kbits/s)	9.6	19.2	93.75	187.5	500	1500	12000
Range / segment	1200 m	1200 m	1200 m	1000 m	400 m	200 m	100 m

5.3 Connection

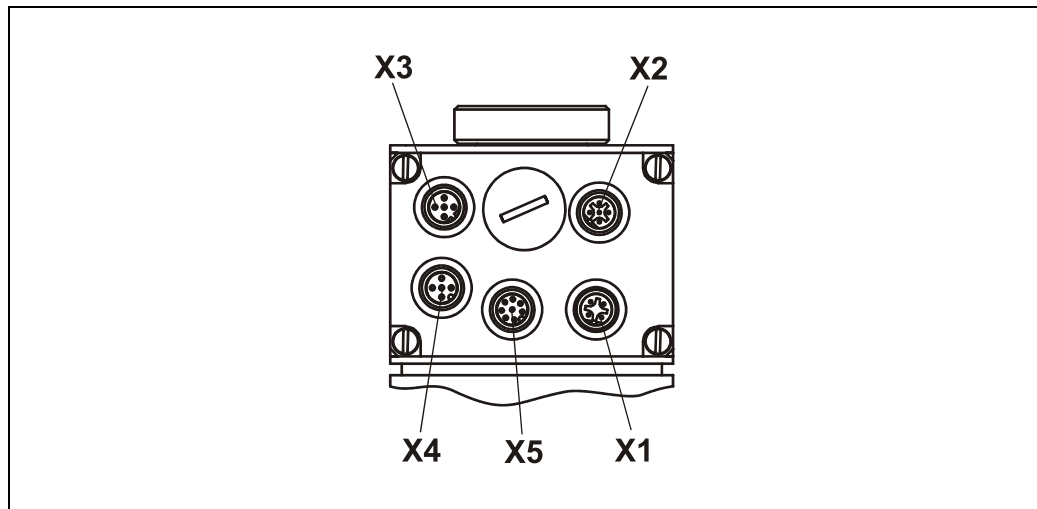


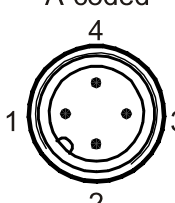
Figure 9: Connector assignment

5.3.1 Supply voltage

NOTICE

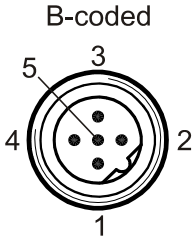
Danger of unnoticed damage to the internal electronics, due to unacceptable overvoltages!

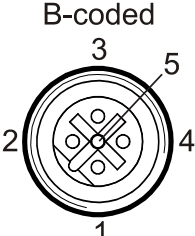
- If an overvoltage of >36 V DC is inadvertently applied, the measuring system must be checked in the factory. The measuring system is permanently switched off for safety reasons, if the overvoltage is applied for more than 200 ms.
 - The measuring system must be shut down immediately
 - When sending the measuring system to the factory, the reasons and circumstances relating to the overvoltage must be specified
 - The power supply used must meet the requirements of SELV/PELV (IEC 60364-4-41:2005)

X1	Signal	Description	Pin, M12x1-4 pole
1	+ 24 V DC (11...27 V DC)	supply voltage	
2	n.c.	-	
3	0 V	GND	
4	n.c.	-	

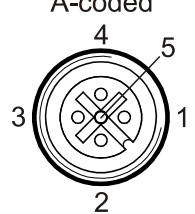
Cable specification: min. 0.5 mm², stranded in pairs and shielded

5.3.2 PROFIBUS

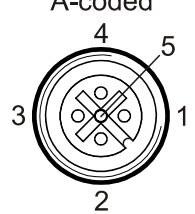
X2	Signal	Description	Pin, M12x1-5 pole
1	n.c.	-	
2	PROFIBUS, Data A	PROFIBUS_IN, green	
3	n.c.	-	
4	PROFIBUS, Data B	PROFIBUS_IN, red	
5	n.c.	-	
Thread		Shielding	

X3	Signal	Description	Socket, M12x1-5 pole
1	+5V	for termination	
2	PROFIBUS Data A	PROFIBUS_OUT, green	
3	GND	for termination	
4	PROFIBUS Data B	PROFIBUS_OUT, red	
5	n.c.	-	
Thread		Shielding	

5.3.3 SIN/COS interface / Incremental interface

X4	Signal	Description	Socket, M12x1-5 pole
1	SIN +	1 Vss, differential	
2	SIN -	1 Vss, differential	
3	COS +	1 Vss, differential	
4	COS -	1 Vss, differential	
5	0 V, GND	Data reference potential	

Alternative with incremental signals

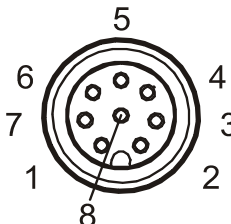
X4'	Signal	Description	Socket, M12x1-5 pole
1	Channel B +	5 V, differential	
2	Channel B -	5 V, differential	
3	Channel A +	5 V, differential	
4	Channel A -	5 V, differential	
5	0 V, GND	Data reference potential	

Cable specification: min. 0.25 mm², stranded in pairs and shielded

5.3.4 Optional external SSI safety channel for termination



The SSI data and the voltage output are not wired in the standard measuring system.

X5	Signal	Description	Socket, M12x1-8 pole
1	SSI-Clock –	Clock output	
2	SSI-Clock +		
3	SSI-Data +	Data input	
4	SSI-Data –		
5	TRWinProg +	Programming interface	
6	TRWinProg –		
7	+24 V DC	Output	
8	0 V, GND	Data reference potential	

Cable specification for the data: min. 0.25 mm², each stranded in pairs and shielded

Cable specification for the supply: min. 0.5 mm², stranded in pairs and shielded

5.4 Bus termination

If the measuring system is the last station in the PROFIBUS segment, the bus must be terminated via flange socket X3 in accordance with the PROFIBUS standard.

The bus termination can also be obtained from TR-Electronic, art. no.: 40803-40005 (M12 connector, B-coded, 220 Ω).



5.5 Bus addressing

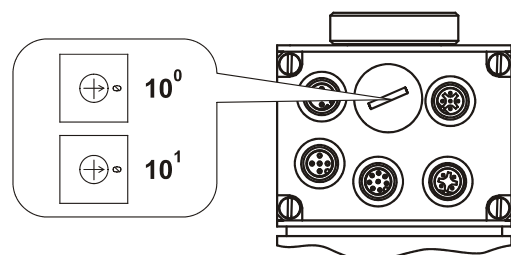
Valid PROFIBUS addresses: 1 – 99

10⁰: Setting the 1st position

10¹: Setting the 10th position

The device will not start up with an invalid station address.

The set PROFIBUS address automatically gives the PROFIsafe destination address, see chapter "F_Source_Add / F_Dest_Add" on page 155.



5.6 SIN/COS interface / Incremental interface

In addition to the PROFIBUS-DP interface for output of the absolute position, the measuring system in the standard version also has a SIN/COS interface.

However, this can alternatively also be designed as an incremental interface.

⚠ WARNING

This additional interface is not evaluated in relation to safety and must not be used for safety-oriented purposes!

- The measuring system checks the outputs of this interface for the feed-in of external voltages. In the event of voltages > 5.7 V, the measuring system is switched off for safety reasons. In this state the measuring system behaves as if it were not connected.
 - The interface is generally used as position feedback for motor control applications.
-

NOTICE

Danger of damage to subsequent electronics due to overvoltages caused by a missing ground reference point!

- If the ground reference point is completely missing, e.g. 0 V of the power supply not connected, voltages equal to the supply voltage can occur at the outputs of this interface.
 - It must be guaranteed that a ground reference point is present at all times.
-

The signal characteristics of the two possible interfaces are shown below.

5.6.1 Signal characteristics of SIN/COS interface

Definitions:

- $V_{SS} = 1\text{ V}$ (0.8...1.2)
- Reference voltage: inverted signals to SIN/COS
- Number of periods per revolution = 4096

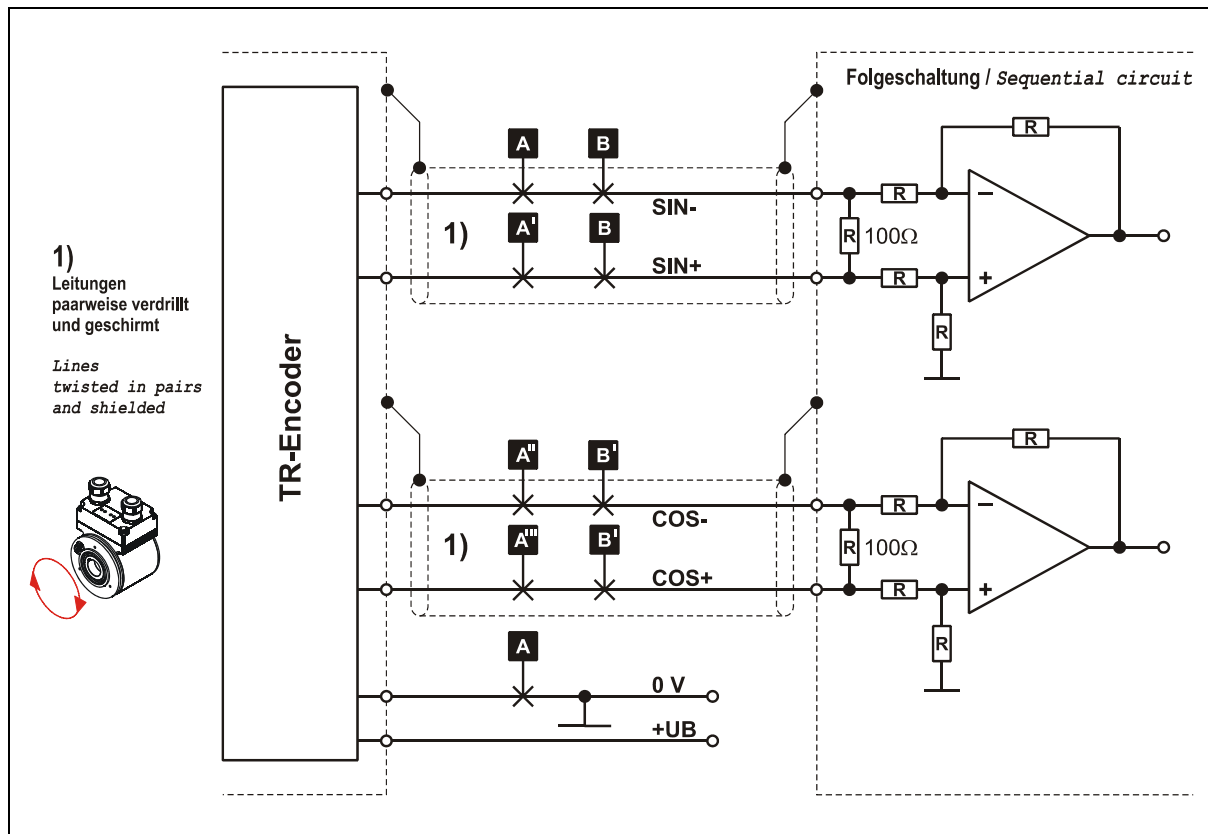


Figure 10: Recommended receiver circuit

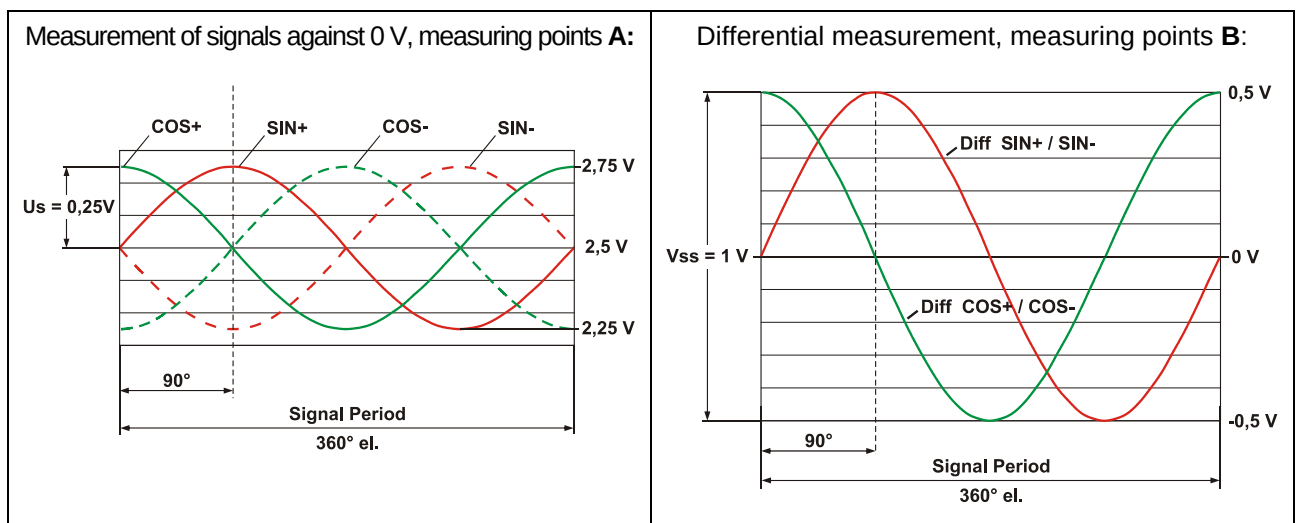


Figure 11: SIN/COS level definition

5.6.2 Signal characteristics of incremental interface

When passing through a revolution, a corresponding number of pulses are output. To evaluate the counting direction, a 2nd signal sequence with a 90° phase offset is output for the control.

The incremental resolution of the measuring system is 4096 pulses / revolution in the standard version. No zero pulse is present.

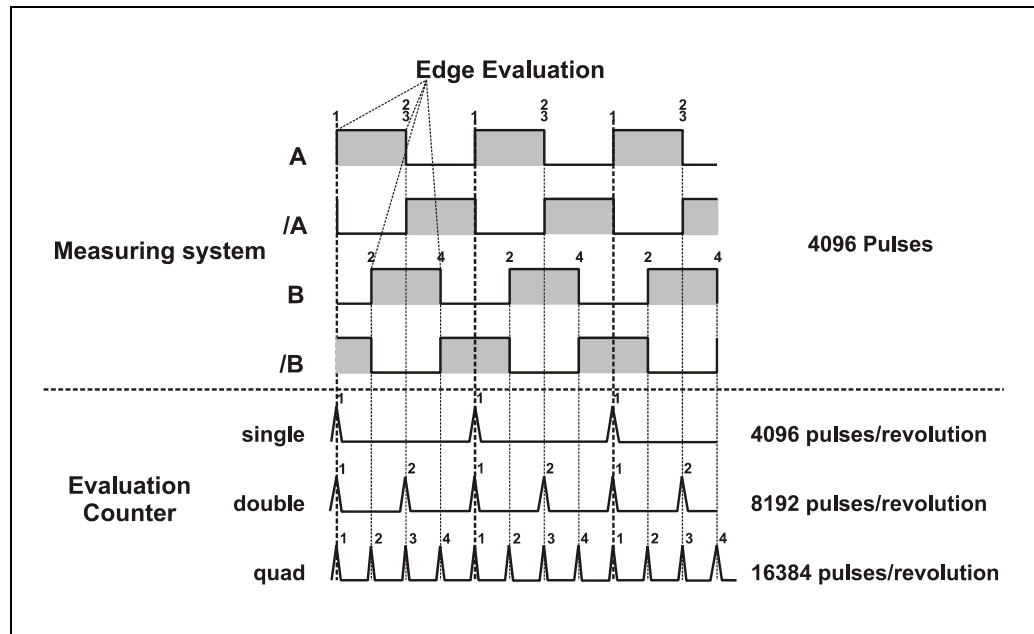


Figure 12: Counter evaluation

6 PROFIBUS / PROFIsafe - Commissioning

6.1 PROFIBUS

PROFIBUS is a continuous, open, digital communication system with a broad range of applications, particularly in manufacturing and process automation. PROFIBUS is suitable for fast, time-sensitive and complex communication tasks.

PROFIBUS communication is based on the international standards IEC 61158 and IEC 61784. The application and engineering aspects are defined in the PROFIBUS User Organization guidelines. These serve to fulfil the user requirements for a manufacturer-independent and open system where the communication between devices from different manufacturers is guaranteed without modification of the devices.

Important information in this regard can be found in the PROFIBUS Guidelines:

- PROFIBUS guideline: PROFIsafe – Environmental Requirements
Order No.: 2.232
- PROFIBUS Assembly Guideline,
Order No.: 8.022
- PROFIBUS Commissioning Guideline,
Order No.: 8.032

These and further information on PROFIBUS or PROFIsafe are available from the offices of the PROFIBUS User Organization:

PROFIBUS Nutzerorganisation e.V.,
 Haid-und-Neu-Str. 7,
 D-76131 Karlsruhe,
<http://www.profibus.com/>
<http://www.profisafe.net/>
 Tel.: ++ 49 (0) 721 / 96 58 590
 Fax: ++ 49 (0) 721 / 96 58 589
 Email: <mailto:germany@profibus.com>

6.1.1 DP communication protocol

The measuring systems support the **DP** communication protocol, which is designed for quick data exchange in the field level. The basic functionality is defined by the performance level **VO**. This includes cyclical data exchange as well as station and module specific diagnosis.

6.1.2 Device master file (GSD)

In order to achieve a simple plug-and-play configuration for PROFIBUS, the characteristic communication features for PROFIBUS devices were defined in the form of an electronic device data sheet (device master file, GSD file).

Using the defined file format, the configuration system can easily read in the device master data of the PROFIBUS measuring system and automatically take account of it in the bus system configuration.

The GSD file is a constituent of the measuring system and has the file name **"TR00CE3.GSE"** (English). The measuring system also has three bitmap files called **"TR0E_BDE.bmp"**, **"TR0E_BDI.bmp"** and **"TR0E_BSF.bmp"**, which it displays in normal mode, in diagnostic mode and in special operating states.

The files are contained on the software/support DVD:

Art. no.: 490-01001, Software no.: 490-00406.

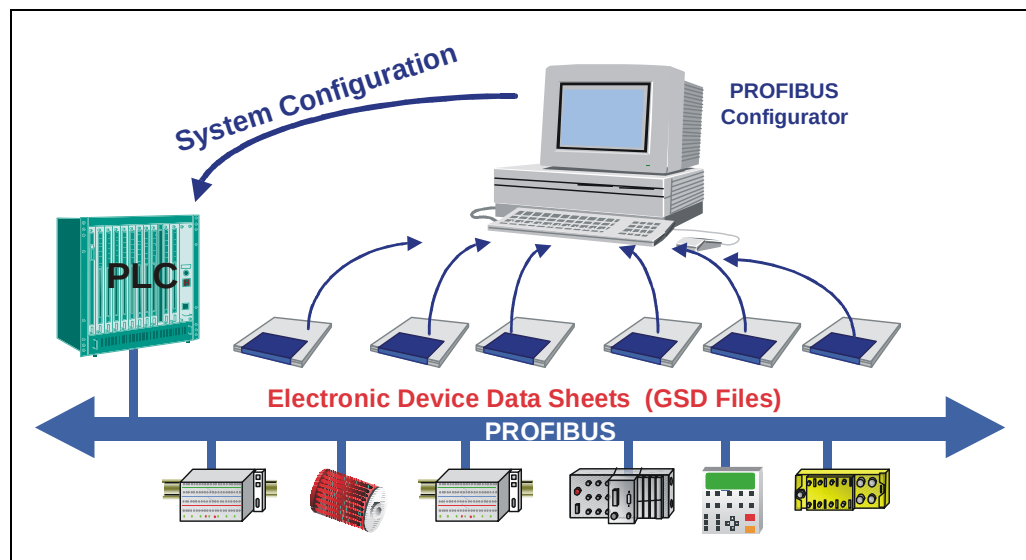


Figure 13: GSD for the configuration

6.1.3 PNO ID number

Every PROFIBUS slave and every Class 1 master must have an ID number. This is already entered in the supplied GSD file.

It is required so that a master can identify the type of the connected device without significant protocol overhead. The master compares the ID numbers of the devices connected with the ID numbers of the configuration data specified in the configuration tool. The transfer of user data only starts once the correct device types have been connected with the correct station addresses on the bus. This achieves a high level of security against configuration errors.

The measuring system has the PNO ID number 0x0CE3 (hex). This number is reserved and is stored with the PNO.

6.2 PROFIsafe

PROFIsafe is the profile for the transfer of safety-oriented data via PROFIBUS and PROFINET and is internationally standardized in IEC 61784-3-3.

PROFIsafe is a functional extension of PROFIBUS-DP and was the first communication standard in accordance with safety standard IEC 61508, which permits standard and fail-safe communication on one and the same bus line. PROFIsafe devices therefore do not require any modifications to the existing hardware components, and can be integrated problem-free into existing systems.

These characteristics are implemented with the "Black-Channel" principle:

- No effect on standard bus protocols
- Independent of the respective transmission channel, whether copper cable, fiber-optic cable, backplane bus or wireless
- Neither the transmission rates nor the respective error detection play a role
- For PROFIsafe the transmission channels are only "Black Channels"

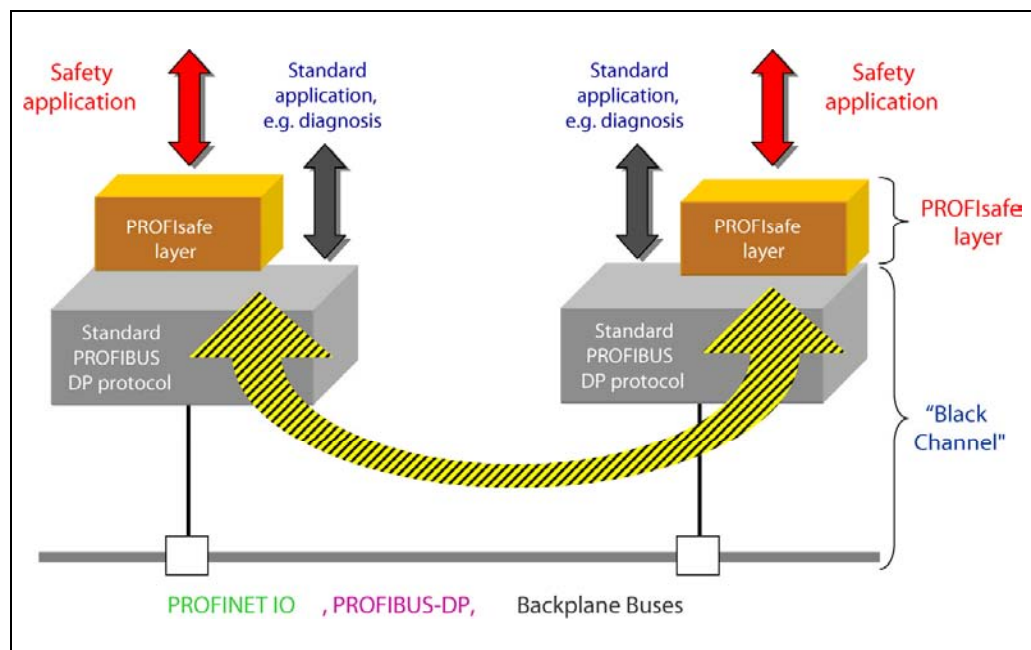


Figure 14: "Black-Channel" principle [source: PROFIsafe system description]

6.3 Measuring system <--> PROFIBUS / PROFIsafe communication

The actual values for position and speed are transmitted in two slots:

- The position actual values of both measuring systems are compared for safe transmission. If the difference is less than the set monitoring window, the value is considered safe. The safe position actual value and the calculated safe speed value are transmitted via the PROFIsafe profile. The part of the control which performs the safety-oriented functions can then process these values.
- The position actual value and the calculated speed value of the first measuring system are directly transmitted in the unsafe process data channel. This channel is generally processed more frequently by the control. This allows normal automation processes to access the updated position value more frequently.

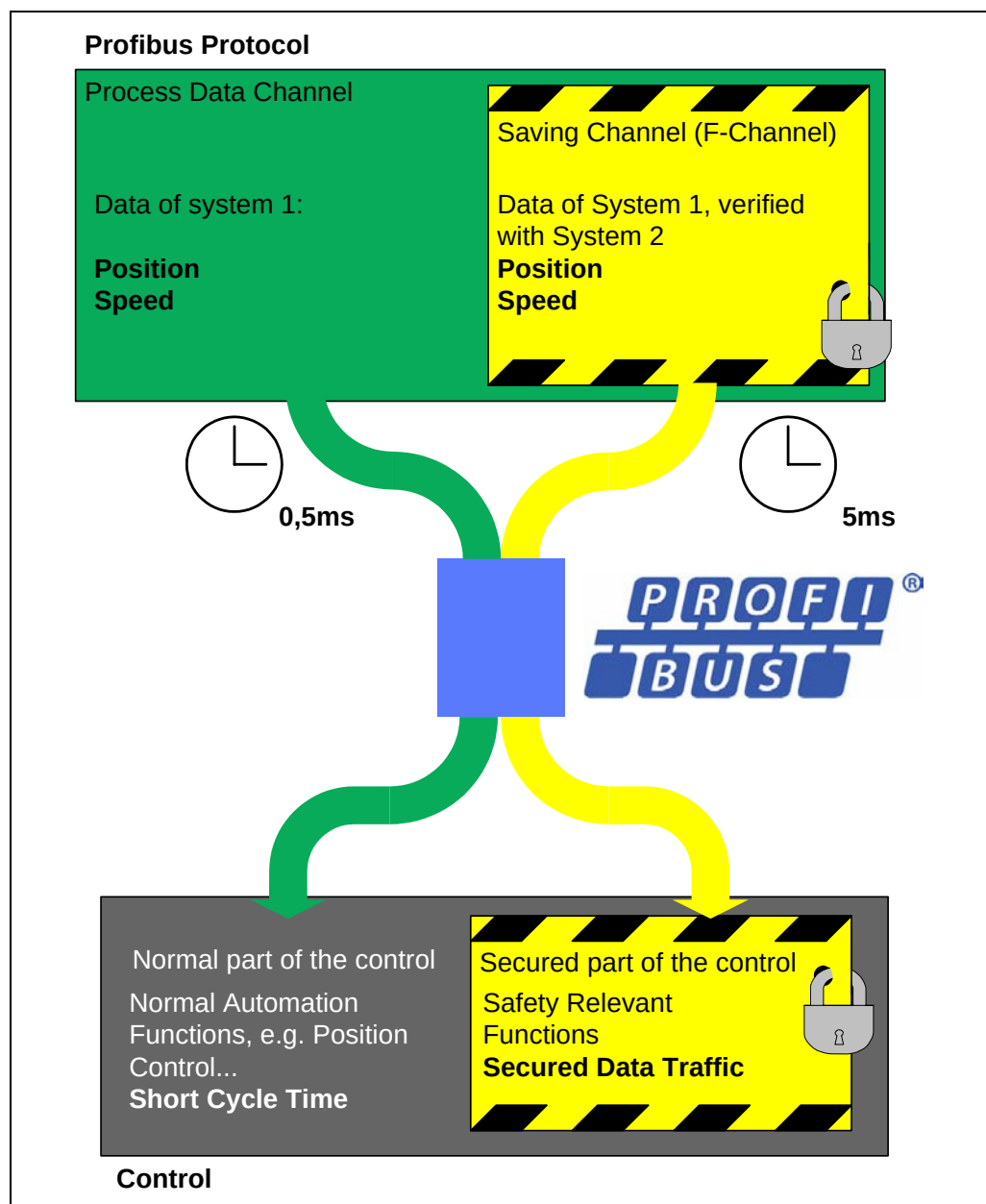


Figure 15: Measuring system - PROFIsafe communication

6.4 Start-up on PROFIBUS

Before the measuring system can be included in the user data traffic (Data_Exchange), the master must first initialize the measuring system during start-up. The resulting data traffic between the master and the measuring system (slave) is divided into the parameterization, configuration and data transfer phases.

It is checked whether the planned nominal configuration agrees with the actual device configuration. The device type, the format and length information as well as the number of inputs and outputs must agree in this check. The user is thus reliably protected against data format errors.

If the check was successful, there is a switch to the DDLM_Data_Exchange mode. In this mode the measuring system transfers e.g. its actual position.

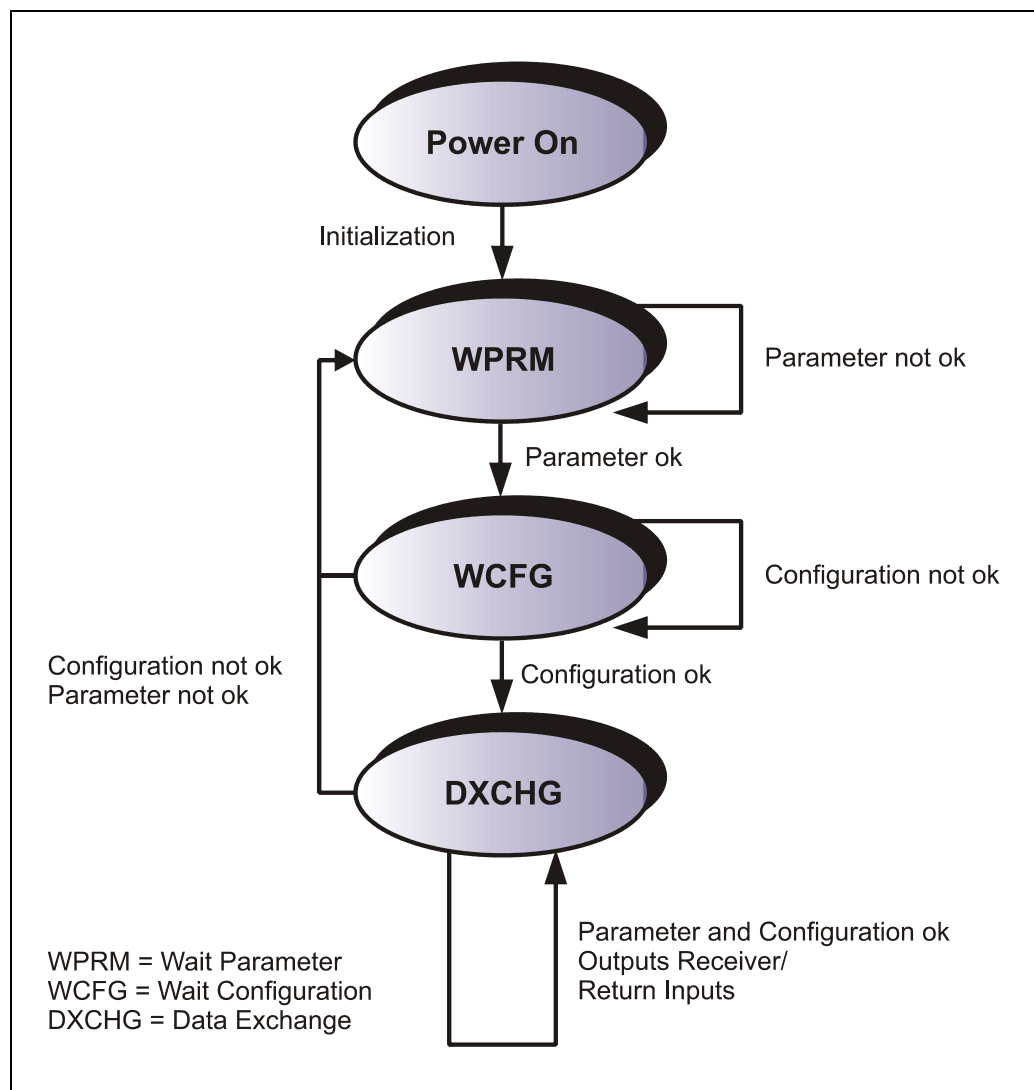
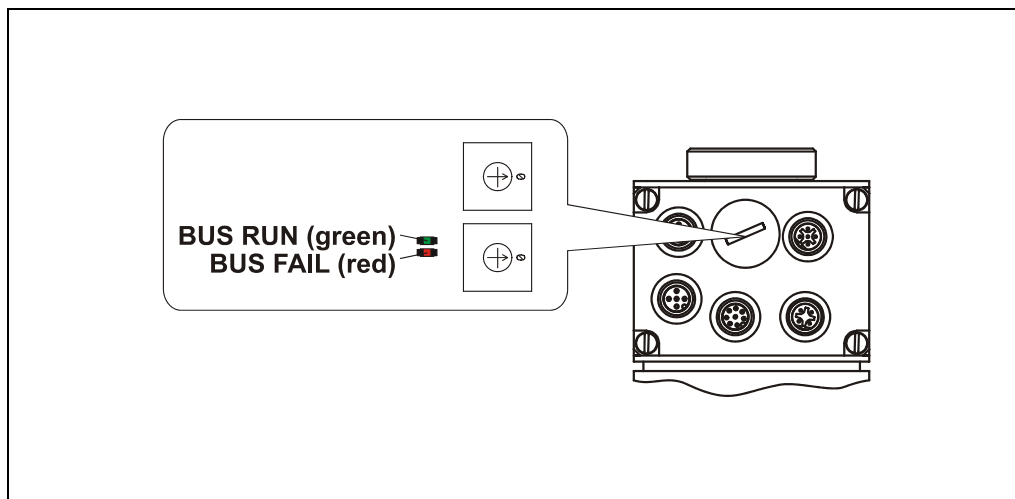


Figure 16: DP slave initialization

6.5 Bus status display

The measuring system has two LEDs in the connection cover. A red LED (bus fail) to display faults and a green LED (bus run) to display status information. When the measuring system starts up, both LEDs flash briefly. The display then depends on the operating status of the measuring system.



- = ON
- = OFF
- ◉ = 1 Hz
- ◉ = 3x with 5 Hz

LED, green	Bus Run
●	Ready for operation
○	Supply absent, hardware error
◉	Incorrect parameterization of F_Parameters
◉	PROFIsafe communication running, master requesting reintegration

LED, red	Bus Fail
○	No error, bus in cycle
◉	Measuring system not addressed by the master, no cyclical data exchange
●	Internal error, Bit 1 set in PROFIsafe status byte

For appropriate measures in case of error, see chapter "Troubleshooting and Diagnosis Options", page 191.

6.6 Configuration

Configuration means that the length and type of process data must be specified and how it is to be treated.

The measuring system uses a defined number of input and output words on the PROFIBUS, depending on the configuration. This structure information is already entered for both the safety-oriented and the non-safety-oriented data in the GSD file, and is described below.

The following definition applies:

Data flow for input data: F-Device --> F-Host

Data flow for output data: F-Host --> F-Device

6.6.1 Safety-oriented data, TR-PROFIsafe module

The module uses five input words for the user data and four input bytes for the PROFIsafe parameter block.

Byte	Bit	Input data	
X+0	2^8-2^{15}	Cam data	Unsigned16
X+1	2^0-2^7		
X+2	2^8-2^{15}	TR-Status	Unsigned16
X+3	2^0-2^7		
X+4	2^8-2^{15}	Speed	Integer16
X+5	2^0-2^7		
X+6	2^8-2^{15}	Actual value, Multi-Turn, 15 bit	Integer16
X+7	2^0-2^7		
X+8	2^8-2^{15}	Actual value, Single-Turn, 13 bit	Integer16
X+9	2^0-2^7		
X+10	2^0-2^7	Safe status	Unsigned8
X+11	$2^{16}-2^{23}$	CRC2	3 Bytes
X+12	2^8-2^{15}		
X+13	2^0-2^7		

The module uses four output words for the user data and four output bytes for the PROFIsafe parameter block.

The Safe-Control Register can only be accessed indirectly via the safety program from an F-Runtime Group.

byte	Bit	Output data	
X+0	2^8-2^{15}	TR-Control1	Unsigned16
X+1	2^0-2^7		
X+2	2^8-2^{15}	TR-Control2	Unsigned16
X+3	2^0-2^7		
X+4	2^8-2^{15}	Preset, Multi-Turn	Integer16
X+5	2^0-2^7		
X+6	2^8-2^{15}	Preset, Single-Turn	Integer16
X+7	2^0-2^7		
X+8	2^0-2^7	Safe Control	Unsigned8
X+9	$2^{16}-2^{23}$	CRC2	3 Bytes
X+10	2^8-2^{15}		
X+11	2^0-2^7		

6.6.2 Register structure of safety-oriented data

6.6.2.1 Input data

6.6.2.1.1 Cam register

Unsigned16

Byte	X+0	X+1
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

Bit	Description
2^0	Speed overflow The bit is set if the speed value is outside the range of –32768...+32767.
$2^1...2^{15}$	reserved

6.6.2.1.2 TR-Status

Unsigned16

Byte	X+2	X+3
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

Bit	Description
2^0	Preset_Status The bit is set if the F-Host triggers a preset request via the variable IPAR_EN of the F-Periphery-DB or the bit Preset_Request in the TR-Control1 register. When the preset has been executed, the bit is automatically reset.
$2^1...2^{14}$	reserved
2^{15}	Error The bit is set if a preset request could not be executed due to excessive speed. The current speed must be in the range of the speed set under Preset Standstill Tolerance. The bit is automatically reset when the speed is in the permissible range.

6.6.2.1.3 Speed

Integer16

Byte	X+4	X+5
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

The speed is output as a two's complement value with preceding sign.

Setting the direction of rotation = forward

- Looking at the flange connection, turn the shaft clockwise:
--> positive speed output

Setting the direction of rotation = backward

- Looking at the flange connection, turn the shaft clockwise:
--> negative speed output

If the measured speed exceeds the display range of –32768...+32767, this results in an overflow, which is reported in the cam register via bit 2⁰. At the time of the overflow the speed stops at the respective +/- maximum value, until the speed is once again in the display range. In this case the message in the cam register is also cleared.

The speed is specified in increments per Integration time Safe.

6.6.2.1.4 Multi turn / Single turn

Multi-Turn, Integer16

Byte	X+6	X+7
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

Single-Turn, Integer16

Byte	X+8	X+9
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

As only 16-bit registers have previously been possible on the control side, the position value must be calculated first. The number of revolutions is noted in the Multi-Turn register, and the current Single-Turn position is noted in steps in the Single-Turn register. Together with the measuring system resolution, max. number of steps per revolution according to type plate, the actual position can then be calculated:

Position in steps = (steps per revolution * number of revolutions) + Single-Turn position

Steps per revolution: 8191 ≙ 13 bit

Number of revolutions: 0...32767 ≙ 15 bit

The output position does not have a preceding sign.

6.6.2.1.5 Safe status

Unsigned8

Byte	X+10
Bit	7 – 0
Data	$2^7 - 2^0$

Bit	Description
2 ⁰	iPar_OK: New iParameter values have been assigned to the F-Device The bit is set when a preset request has been successfully completed via the F-Host (iPar_EN bit), see chapter "Preset Adjustment Function" on page 189.
2 ¹	Device_Fault: Error in F-Device or F-Module The bit is set if the value set for the window increments under the iParameters has been exceeded and/or the internally calculated PROFIsafe telegram is defective. The measuring system is then put into fail-safe status and outputs its passivated data. It is only possible to leave this status by eliminating the error and turning the supply voltage OFF/ON.
2 ²	CE_CRC: Checksum error in communication The bit is set if the F-Device detects an F-Communication error, such as e.g. an incorrect consecutive number (detected via a CRC2 error in V2 mode) or if the data integrity has been violated (CRC error). The F-Host must then count all defective messages within a defined time period T and assume a configured safe status in the event of exceeding the maximum permissible defective messages. This error can also be triggered by incorrect CRC values in the iParameters (F_iPar_CRC) or F-Parameters (F_Par_CRC) in the parameterization sequence. The measuring system reports a parameter error via the PROFIBUS standard diagnosis and does not start up.
2 ³	WD_timeout: Watchdog timeout during communication The bit is set if the set watchdog time F_WD_Time in the F-Parameters is exceeded. A valid current safety telegram must arrive from the F-Host within this time, otherwise the measuring system will be set to fail-safe status and output its passivated data. It is only possible to leave this status by eliminating the error and turning the supply voltage OFF/ON. Also see chapter F_WD_Time on page 155.
2 ⁴	FV_activated: Fail-safe values activated The bit is set when the measuring system is in fail-safe status and outputs its passivated data.
2 ⁵	Toggle_d: Toggle bit The toggle bit is device-based and causes the incrementation of the virtual consecutive number in the F-Host. The toggle bit is used to synchronize the counters in the measuring system/F-Host for generation of the virtual consecutive number.
2 ⁶	cons_nr_R: Virtual consecutive number has been reset The counter is reset if the F-Host detects an F-Communication error (CE_CRC).
2 ⁷	reserved



Safe status can only be indirectly accessed from a F-Runtime Group via the safety program with the aid of variables of the F-Periphery-DB, see chapter "Access to the safety-oriented data channel" on page 183.

6.6.2.2 Output data

6.6.2.2.1 TR-Control1

Unsigned16

Byte	X+0	X+1
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

Bit	Description
2^0	Preset_Request The bit serves to control the preset adjustment function. When this function is executed, the measuring system is set to the position value stored in the Preset Multi-Turn/Preset Single-Turn registers. A precise sequence must be observed in order to execute the function, see chapter "Preset Adjustment Function" on page 189.
$2^1 \dots 2^{15}$	reserved

6.6.2.2.2 TR-Control2

Reserved.

6.6.2.2.3 Preset multi turn / Preset single turn

Preset Multi-Turn, Integer16

Byte	X+4	X+5
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

Preset single turn, Integer16

Byte	X+6	X+7
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

As only 16-bit registers have previously been possible on the control side, the preset value to be written must be calculated first. The desired preset value must be in the range of 0 to 268 435 455 (28 bit). Together with the measuring system resolution, max. number of steps per revolution according to type plate (8192), the corresponding values for Preset Multi-Turn/Preset Single-Turn can then be calculated:

Number of revolutions = desired preset value / steps per revolution

The integer part from this division gives the number of revolutions and must be entered in the Preset Multi-Turn register.

Single-Turn-Position = desired preset value – (steps per revolution * no. of revolutions)

The result of this calculation is entered in the Preset Single-Turn register.

The preset value is set as new position when the preset adjustment function is executed, see chapter "Preset Adjustment Function" on page 189.

6.6.2.2.4 Safe-Control

Unsigned8

Byte	X+8
Bit	7 – 0
Data	$2^7 - 2^0$

Bit	Description
2^0	iPar_EN: iParameter assignment unlocked The bit must be set indirectly via a variable of the F-Host in order to be able to execute the preset adjustment function, see chapter "Preset Adjustment Function" on page 189.
2^1	OA_Req: Operator acknowledgement required The bit is set by the F-Host driver after detection and elimination of an error in the safety-oriented communication. The bit is also set if the measuring system/F-Host could not be synchronously integrated into the bus operation at start-up of the F-System. An operator acknowledgement is displayed via the green LED (3x with 5 Hz) in relation to the measuring system. In this case a reintegration of the function blocks contained in the safety program must be performed. In this way the counters contained in the F-Host and F-Device for the virtual consecutive numbers are synchronized. The measuring system is then reset from safe status, output of passivated data, to normal status, output of cyclical data.
2^2	R_cons_nr: Resetting of the counter for the virtual consecutive no. The bit is set when the F-Host detects an F-Communication error, either via the status byte or itself.
2^3	reserved
2^4	activate_FV: Activate fail-safe values The bit is set inside the device via the firmware if the measuring system can no longer output fail-safe data due to a device error, errors in the safety-oriented communication or at start-up of the F-System. The measuring system outputs its passivated data instead.
2^5	Toggle_h: Toggle bit The toggle bit is host-based and causes the incrementation of the virtual consecutive numbers in the F-Device. The toggle bit is used to synchronize the counters in the measuring system/F-Host for generation of the virtual consecutive number.
2^6-2^7	reserved



The Safe-Control register can only be indirectly accessed from a F-Runtime Group via the safety program with the aid of variables of the F-Periphery-DB, see chapter "Access to the safety-oriented data channel" on page 183.

6.6.3 Process data, TR-PROFIBUS module

The module uses four input words for pure user data, which are not safety-oriented.

Byte	Bit	Input data	
X+0	2^8-2^{15}	Cam data	Unsigned16
X+1	2^0-2^7		
X+2	2^8-2^{15}	Speed	Integer16
X+3	2^0-2^7		
X+4	2^8-2^{15}	Actual value, Multi-Turn, 15 bit	Integer16
X+5	2^0-2^7		
X+6	2^8-2^{15}	Actual value, Single-Turn, 13 bit	Integer16
X+7	2^0-2^7		

6.6.4 Register structure of the process data

6.6.4.1 Input data

6.6.4.1.1 Cam register

Unsigned16

Byte	X+0	X+1
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

Bit	Description
2^0	Speed overflow The bit is set if the speed value is outside the range of –32768...+32767.
$2^1...2^{15}$	reserved

6.6.4.1.2 Speed

Integer16

Byte	X+2	X+3
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

The speed is output as a two's complement value with preceding sign.

Setting the direction of rotation = forward

- Looking at the flange connection, turn the shaft clockwise:
--> positive speed output

Setting the direction of rotation = backward

- Looking at the flange connection, turn the shaft clockwise:
--> negative speed output

If the measured speed exceeds the display range of –32768...+32767, this results in an overflow, which is reported in the cam register via bit 2^0 . At the time of the overflow the speed stops at the respective +/- maximum value, until the speed is once again in the display range. In this case the message in the cam register is also cleared.

The speed is specified in increments per Integration time Unsafe.

6.6.4.1.3 Multi turn / Single turn

Multi-Turn, Integer16

Byte	X+4	X+5
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

Single-Turn, Integer16

Byte	X+6	X+7
Bit	15 – 8	7 – 0
Data	$2^{15} - 2^8$	$2^7 - 2^0$

As only 16-bit registers have previously been possible on the control side, the position value must be calculated first. The number of revolutions is noted in the Multi-Turn register, and the current Single-Turn position is noted in steps in the Single-Turn register. Together with the measuring system resolution, max. number of steps per revolution according to type plate, the actual position can then be calculated:

$\text{Position in steps} = (\text{steps per revolution} * \text{number of revolutions}) + \text{Single-Turn position}$

Steps per revolution: 8191 $\triangleq$ 13 bit

Number of revolutions: 0...32767 $\triangleq$ 15 bit

The output position does not have a preceding sign.

6.7 Parameterization

Parameterization means providing a PROFIBUS-DP slave with certain information required for operation prior to commencing the cyclic exchange of process data. The measuring system requires e.g. data for the integration time, counting direction etc.

Normally the configuration program provides an input box for the PROFIBUS-DP master with which the user can enter parameter data or select from a list. The structure of the input box is stored in the device master file. The number and type of parameters entered by the user depend on the configuration.

DANGER

- **Danger of death, serious physical injury and/or damage to property due to malfunction, caused by incorrect parameterization!**

NOTICE

- The system manufacturer must ensure correct functioning by carrying out a protected test run during commissioning and after each parameter change.

6.7.1 F-Parameters (F_Par)

The F-Parameters contain information for adapting the PROFIsafe layer to defined applications and checking the parameterization using an independent separate method. The F-Parameters supported by the measuring system are listed below.

Byte order = Big Endian

Byte	Parameter	Type	Description	Page
X+0	F_Check_SeqNr	Bit	Bit 0 = 0: No check	155
	-	Bit	Bit 1 = 0: not used	-
	F_SIL	Bit range	Bit 3-2 00: SIL1 01: SIL2 10: SIL3 [default] 11: no SIL	155
	F_CRC_Length	Bit range	Bit 5-4 00: 3-Byte-CRC	155
X+1	F_Block_ID	Bit range	bit 5-3 001: 1	155
	F_Par_Version	Bit range	Bit 7-6 01: V2-Mode	155
X+2	F_Source_Add	Unsigned16	Source address, Default = 1 Range: 1-65534	155
X+4	F_Dest_Add	Unsigned16	Destination address, Default = 503 Range: 1-65534	155
X+6	F_WD_Time	Unsigned16	Watchdog time, Default = 125 Range: 125-10000	155
X+8	F_iPar_CRC	Unsigned32	CRC of i-Parameters, Default = 1132081116 Range: 0-4294967295	156
X+12	F_Par_CRC	Unsigned16	CRC of F-Parameters, Default = 46906 Range: 0-65535	156

6.7.1.1 F_Check_SeqNr

The parameter defines whether the sequence number will be included in the consistency check (CRC2 calculation) of the F-User Data telegram. The parameter is set to "NoCheck" and cannot be changed. This means that only fail-safe DP standard slaves are supported, which behave accordingly.

6.7.1.2 F_SIL

F_SIL specifies the SIL which the user expects from the respective F-Device. This is compared with the locally saved manufacturer's specification. The measuring system supports safety class SIL3 = standard value.

6.7.1.3 F_CRC_Length

Depending on the length of the F input/output data (12 or 123 bytes) and the SIL level, a CRC of 2, 3 or 4 bytes is required. In order to check the data, this parameter transmits the expected length of the CRC2 signature in the safety protocol to the F-Component during start-up. The measuring system supports the CRC length of 3 bytes. This value is predefined and cannot be changed.

6.7.1.4 F_Block_ID

This parameter specifies whether a CRC should also be formed using the device-specific safety parameters "F_iPar". As the measuring system supports device-specific safety parameters such as e.g. "Integration time Safe", this parameter is preconfigured with the value "1 = generate F_iPar_CRC" and cannot be changed.

6.7.1.5 F_Par_Version

The parameter identifies the PROFIsafe version "V2-Mode" implemented in the measuring system. This value is predefined and cannot be changed.

6.7.1.6 F_Source_Add / F_Dest_Add

The parameter F_Source_Add defines a unique source address within a PROFIsafe cluster. The parameter F_Dest_Add defines a unique destination address within a PROFIsafe cluster.

The device-specific part of the F-Devices compares the value with the in-situ address switch or an assigned F-Address, to check the authenticity of the connection.

The PROFIsafe destination address corresponds to the PROFIBUS address + 500, set by the address switch implemented in the measuring system.

Valid addresses: 501...599.

Standard value F_Source_Add = 1, Standard value F_Dest_Add = 503.

6.7.1.7 F_WD_Time

This parameter defines the monitoring time [ms] in the measuring system. A valid current safety telegram must arrive from the F-Host within this time, otherwise the measuring system will be set to safe status.

The predefined value is 125 ms.

The watchdog time must generally be set at a level where telegram runtimes are tolerated by the communication, but it must also allow quick execution of the error reaction function in case of error.

6.7.1.8 F_iPar_CRC

This parameter represents the checksum value (CRC2), which is calculated from all iParameters of the device-specific part of the measuring system and ensures safe transmission of the iParameters. The calculation occurs in a program called "TR_iParameter" provided by TR-Electronic. The checksum value calculated there must then be manually entered in the F-Host engineering tool, also see chapter "Parameter Definition / CRC Calculation" on page 159.

The measuring system also generates a checksum itself from the iParameters transferred by the F-Host. This checksum is compared with the checksum transferred by the F-Host in the measuring system. If both F_iPar_CRC are identical, the measuring system is put into data exchange mode at start-up, otherwise it does not start up.

To calculate the F_iPar_CRC, the 32-bit CRC polynomial 0x04C11DB7 is used in both the measuring system and in the TR_iParameter program.

Standard value = 1132081116, valid for all iParameters with default setting.

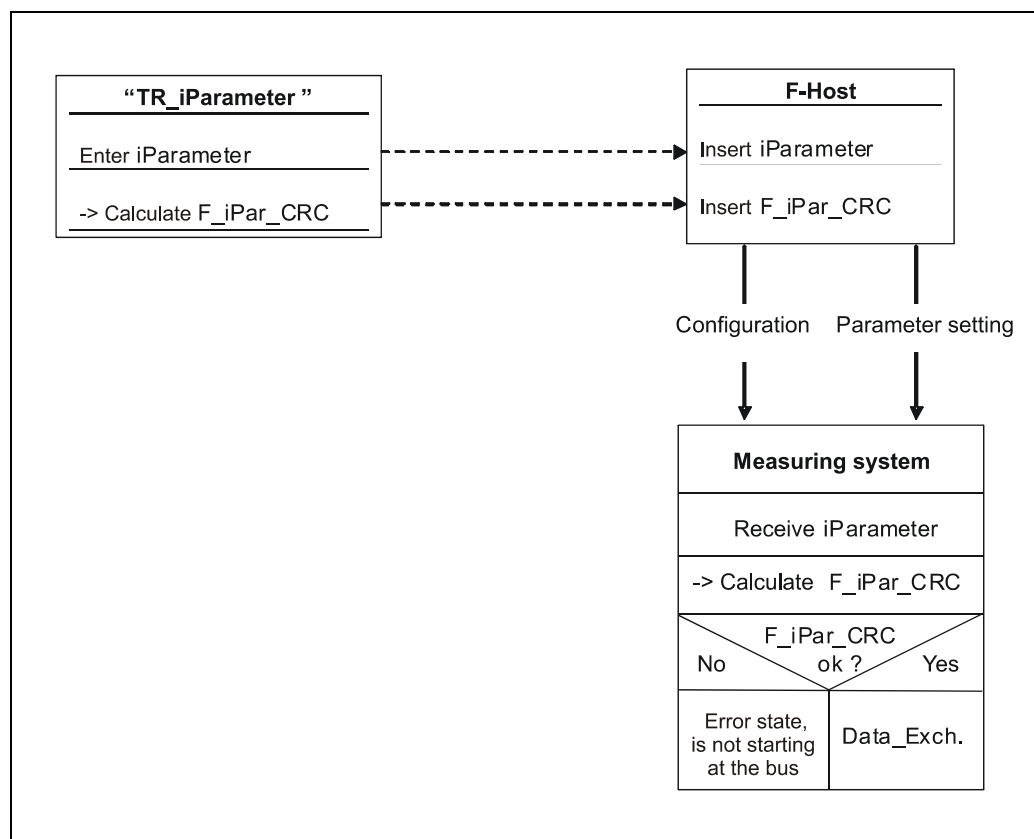


Figure 17: Diagram of the F_iPar_CRC calculation

6.7.1.9 F_Par_CRC

This parameter represents the checksum value (CRC1), which is calculated from all F-Parameters of the measuring system and ensures safe transmission of the F-Parameters. The calculation occurs externally in the F-Host engineering tool and must then be entered here under this parameter, or is generated automatically.

The CRC1 checksum value is also the start value for the cyclical CRC2 calculation.

The 16-bit CRC polynomial 0x4EAB is used to calculate the F_Par_CRC.

Standard value = 46906, valid for all F-Parameters with default setting.

6.7.2 iParameters (F_iPar)

Application-dependent device characteristics are defined with the iParameters. A CRC calculation is necessary for safe transmission of the iParameters, see chapter "iParameters" on page 159.

The iParameters supported by the measuring system are listed below.

Byte order = Big Endian

Byte	Parameter	Type	Description	Page
X+0	Integration time Safe	Unsigned16	Default = 2 Range: 1-10	157
X+2	Integration time Unsafe	Unsigned16	Default = 20 Range: 1-100	157
X+4	Window increments	Unsigned16	Default = 1000 Range: 50-4000	157
X+6	Idleness tolerance Preset	Unsigned8	Default = 1 Range: 1-5	157
X+7	Direction	Bit	0: Decreasing counting direction 1: Increasing counting direction [default]	158

6.7.2.1 Integration time Safe

This parameter is used to calculate the safe speed, which is output via the cyclical data of the PROFIsafe module. High integration times enable high-resolution measurements at low speeds. Low integration times show speed changes more quickly and are suitable for high speeds and high dynamics. The time basis is predefined to 50 ms. 50...500 ms can thus be set using the value range of 1...10. Standard value = 100 ms.

6.7.2.2 Integration time Unsafe

This parameter is used to calculate the unsafe speed, which is output via the process data of the PROFIBUS module. High integration times enable high-resolution measurements at low speeds. Low integration times show speed changes more quickly and are suitable for high speeds and high dynamics. The time basis is predefined to 5 ms. 5...500 ms can thus be set using the value range of 1...100. Standard value = 100 ms.

6.7.2.3 Window increments

This parameter defines the maximum permissible position deviation in increments of the master / slave scanning units integrated into the measuring system. The permissible tolerance window is basically dependent on the maximum speed occurring in the system and must first be determined by the system operator. Higher speeds require a larger tolerance window. The value range extends from 50...4000 increments. Standard value = 1000 increments.

6.7.2.4 Idleness tolerance Preset

This parameter defines the maximum permissible speed in increments per Integration time Safe for performance of the preset function. The permissible speed is dependent on the bus behavior and the system speed, and must be determined by the system operator first. The value range extends from 1 increment per Integration time Safe to 5 increments per Integration time Safe. Standard value = 1 increment per standard value Integration time Safe.

6.7.2.5 Direction

This parameter defines the current counting direction of the position value looking at the flange connection, turning the shaft clockwise.

Forward = Counting direction increasing
Backward = Counting direction decreasing

Standard value = Forward.

7 Parameter Definition / CRC Calculation

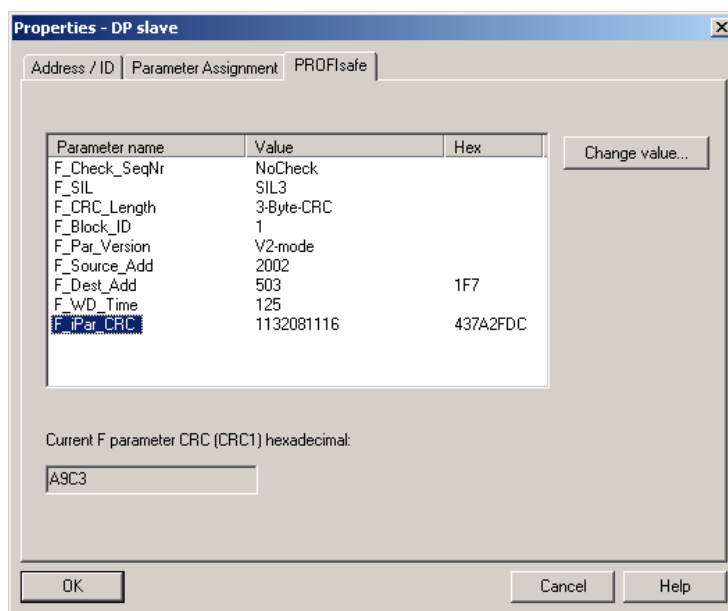
It is best to define the known parameters before configuration in the F-Host, so that they can be taken into account during configuration.

The procedure, in conjunction with the SIEMENS configuration software SIMATIC Manager and the optional package S7 Distributed Safety, is described below. The TR_iParameter software required for the CRC calculation is a constituent of the software and support DVD, art. no.: 490-01001, also see chapter "Accessories" on page 206.

The program can be found on this DVD under
English --> Tools --> CRC calculation, TR_iParameter.

7.1 iParameters

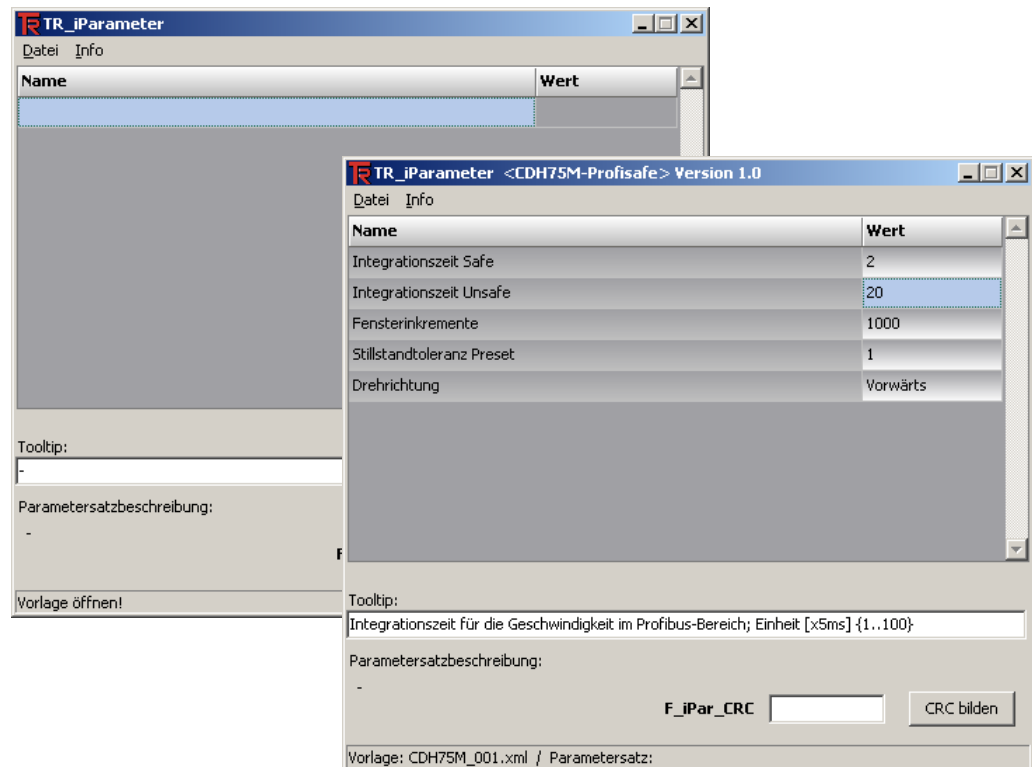
The iParameters are preconfigured with meaningful values in the default setting and should only be changed if expressly required by the automation task. A CRC calculation is necessary for safe transmission of the individually set iParameters. This must be performed when changing the predefined iParameters via the TR program "TR_iParameter". The calculated checksum corresponds to the F-Parameter F_iPar_CRC. This must be entered in the field with the same name in the Properties – DP slave window when configuring the measuring system with the hardware configurator, also see chapter "Setting the iParameters" on page 174.



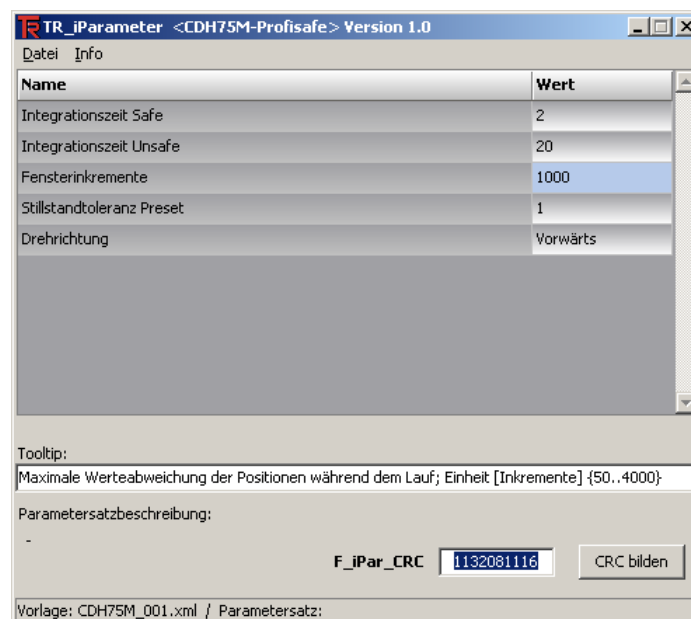
7.1.1 CRC calculation across the iParameters

The predefined standard values are used for the following example of a CRC calculation. These can be loaded in the TR_iParameter program using an XML template file. If different values are required, the standard values can be overwritten by double-clicking on the relevant entry. The modified parameters can be saved as a complete parameter set or opened again as a template.

- Start TR_iParameter by means of the start file "TR_iParameter.exe", then open the template file provided with the measuring system with the menu Datei --> Vorlage öffnen... (as example here: CDH75M_001.xml).



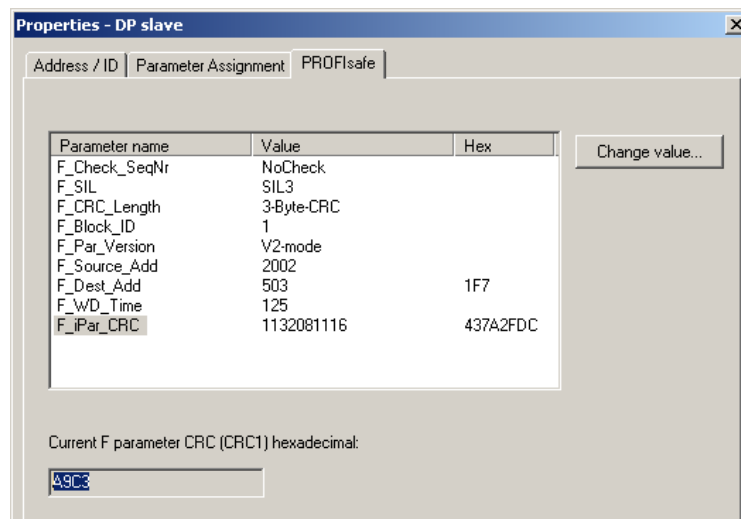
- Modify the relevant parameters if necessary, then click on the CRC bilden switch for the F_iPar_CRC calculation.



Each parameter change requires a new F_iPar_CRC calculation, which must then be taken into account in the projection. If a safety program is already present, it must be re-generated.

7.2 F-Parameters

The F-Parameters are already preconfigured with meaningful values in the default setting and should only be changed if expressly required by the automation task. A CRC which is automatically calculated by the SIMATIC Manager is necessary for safe transmission of the individually set F-Parameters. This checksum corresponds to the F-Parameter F_Par_CRC, which is displayed as a hexadecimal value in the Properties - DP slave window under the heading Current F parameter CRC (CRC1) when configuring the measuring system with the hardware configurator: The value A9C3 entered in the example below is valid for the default setting shown here, also see chapter "Setting the F-Parameters" on page 175.



7.2.1 Non-settable F-Parameters

The F-Parameters specified below are either managed by the measuring system or by the F-Host, and therefore cannot be manually changed:

- F_Check_SeqNr: NoCheck
- F_CRC_Length: 3-Byte-CRC
- F_Block_ID: 1
- F_Par_Version: V2-mode
- F_Source_Add: 2002 (example value, is predefined by the F-Host)

7.2.2 Settable F-Parameters

It is assumed that the following parameters are configured with their standard values:

- F_SIL: SIL3
- F_Dest_Add: 503 (corresponds to the set PROFIBUS address +500)
- F_WD_Time: 125
- F_iPar_CRC: 1132081116 (calculation by means of TR tool TR_iParameter)

Each parameter change gives a new F_Par_CRC value, which is displayed as shown above. If a safety program is already present, it must be re-generated.

8 Safety Program Creation - Configuration Example

This chapter describes the procedure for creating the safety program using the SIEMENS SIMATIC Manager configuration software and the S7 Distributed Safety optional package.

The safety program is created with the FBD/LAD Editor in STEP 7. The fail-safe FBs and FCs are programmed in the F-FBD or F-LAD programming language, while the fail-safe DBs are created in the F-DB programming language. The Distributed Safety F-Library supplied by SIEMENS provides the user with fail-safe application modules, which can be used in the safety program.

When generating the safety program, safety checks are performed automatically and additional fail-safe blocks are integrated for error detection and error reaction. This ensures that failures and errors are detected and corresponding reactions are triggered, which keep the F-System in safe status or put it into a safe status.

A standard user program can run in the F-CPU in addition to the safety program. The co-existence of standard and safety program in the F-CPU is possible, as the safety-oriented data of the safety program are protected against undesirable influence by data of the standard user program.

Data exchange between safety and standard user program in the F-CPU is possible by means of flags and through access to the process image of the inputs and outputs.

Access protection

Access to the F-System S7 Distributed Safety is protected by two passwords, the password for the F-CPU and the password for the safety program. A differentiation is made between offline and online password for the safety program:

- The offline password is part of the safety program in the offline project on the programming device.
- The online password is part of the safety program in the F-CPU.

8.1 Prerequisites

WARNING

Danger of deactivation of the fail-safe function through incorrect configuration of the safety program!

- The safety program must be created in conjunction with the system documentation provided by SIEMENS for the software and hardware.
 - Extensive documentation on "Configuring and Programming" a safe control is provided by SIEMENS in its manual ***S7 Distributed Safety - Configuring and Programming***, document order number: ***A5E00109537-04***. This documentation is a constituent of the optional package S7 Distributed Safety.
 - The following descriptions relate to the pure procedure and do not take account of the instructions from the SIEMENS manual. It is therefore essential to observe and comply with the information and instructions provided in the SIEMENS manual, particularly the safety instructions and warnings.
 - The configuration shown should be taken as an example. The user is required to check and adapt the usability of the configuration for his own application. This also includes the selection of suitable safety-oriented hardware components and the necessary software prerequisites.
-

Software components used for the S7 Distributed Safety configuration example:

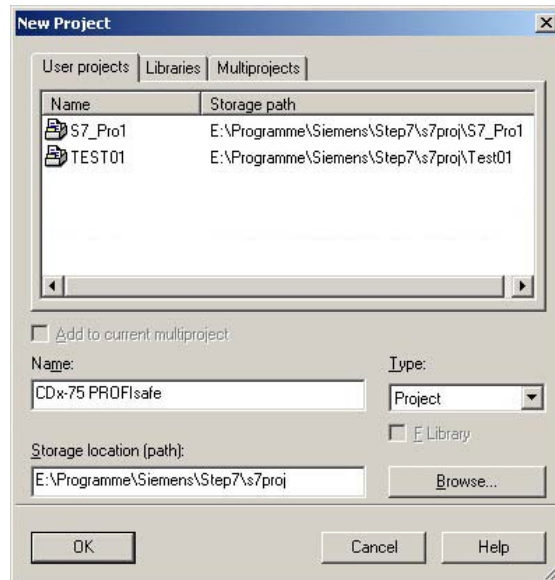
- STEP 7 V5.4 + SP5
- S7 Distributed Safety Programming V5.4 + SP4
- S7 F ConfigurationPack V5.5 + SP4

Hardware components in the SIMATIC 300 series used for the S7 Distributed Safety configuration example:

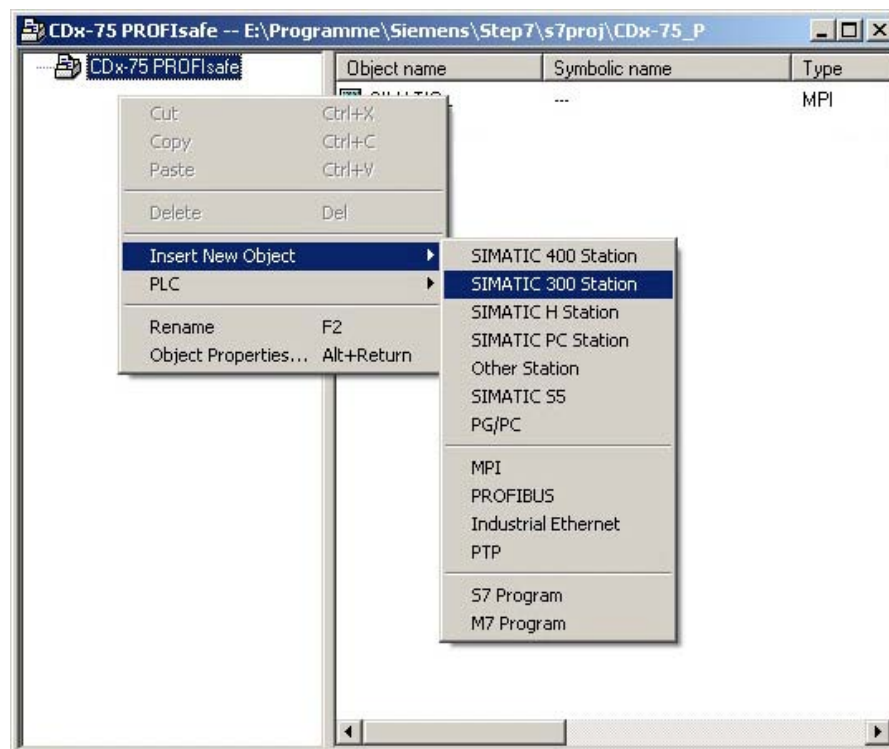
- Rail
- Power supply "PS307 2A" (307-1BA00-0AA0)
- F-CPU unit "CPU317F-2 PN/DP" (317-2FK13-0AB0)
- Digital output module "SM 326F DO 10xDC24V/2A" (326-2BF01-0AB0), is not actively used in the following safety program and is intended for customer-specific outputs, e.g. to show the variable states of the F-Periphery-Block: PASS_OUT, QBAD, ACK_REQ, IPAR_OK etc.
- Digital input module "SM 326F DI 24xDC24V" (326-1BK01-0AB0), is used for the user acknowledgement (reintegration)

8.2 Hardware configuration

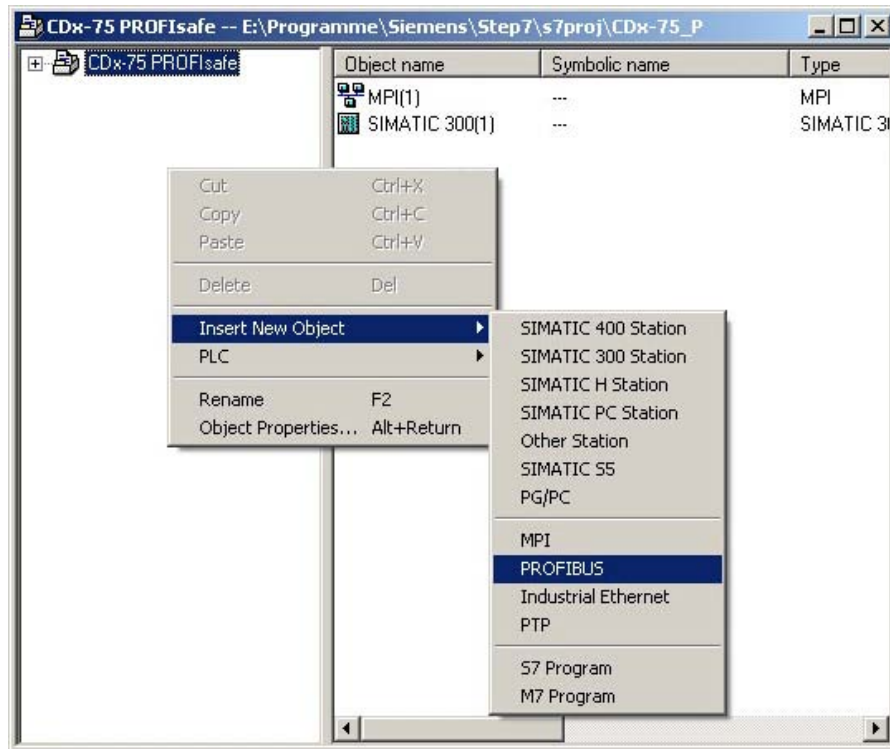
- Start SIMATIC Manager and create a new project



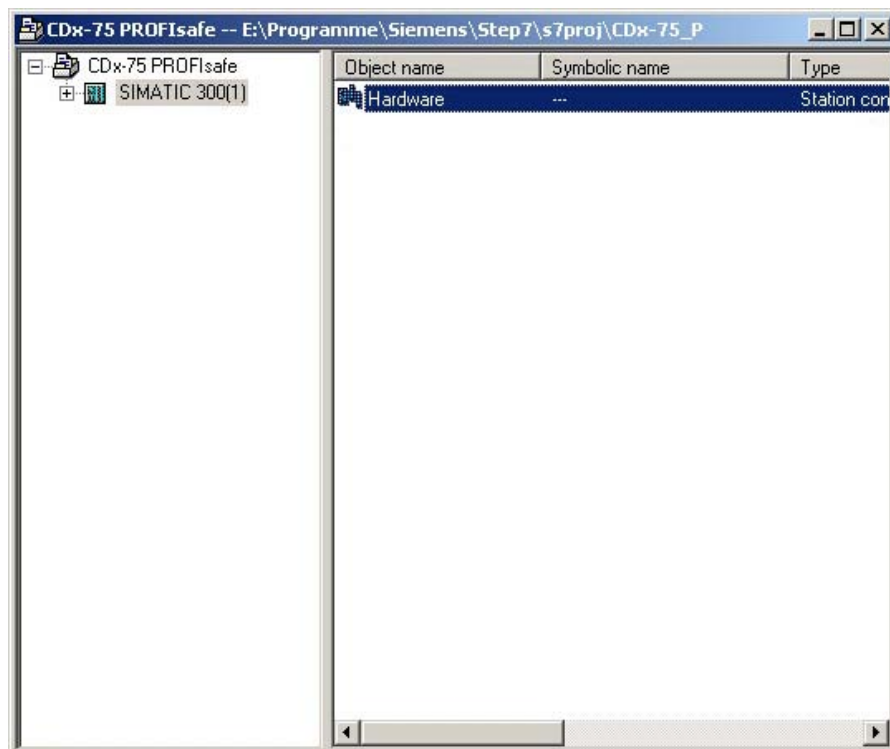
- Using the right mouse button, insert the SIMATIC 300 Station as a new object in the project window



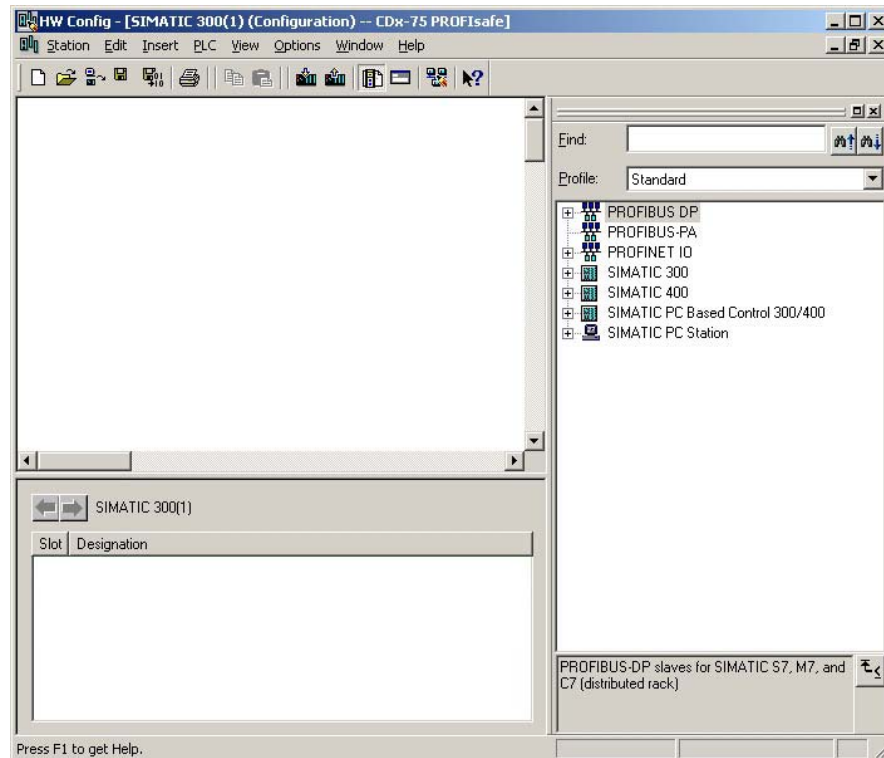
- Insert a PROFIBUS as a new object in the same way. An Industrial Ethernet must also be inserted at this point if necessary.



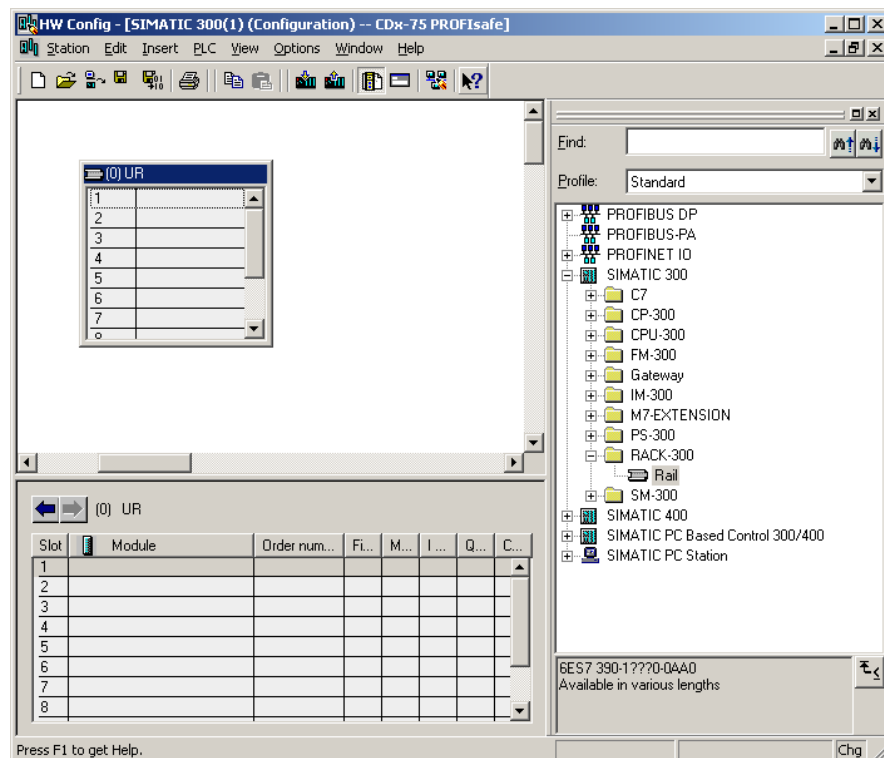
- Double-click on Hardware to start the hardware configurator HW Config



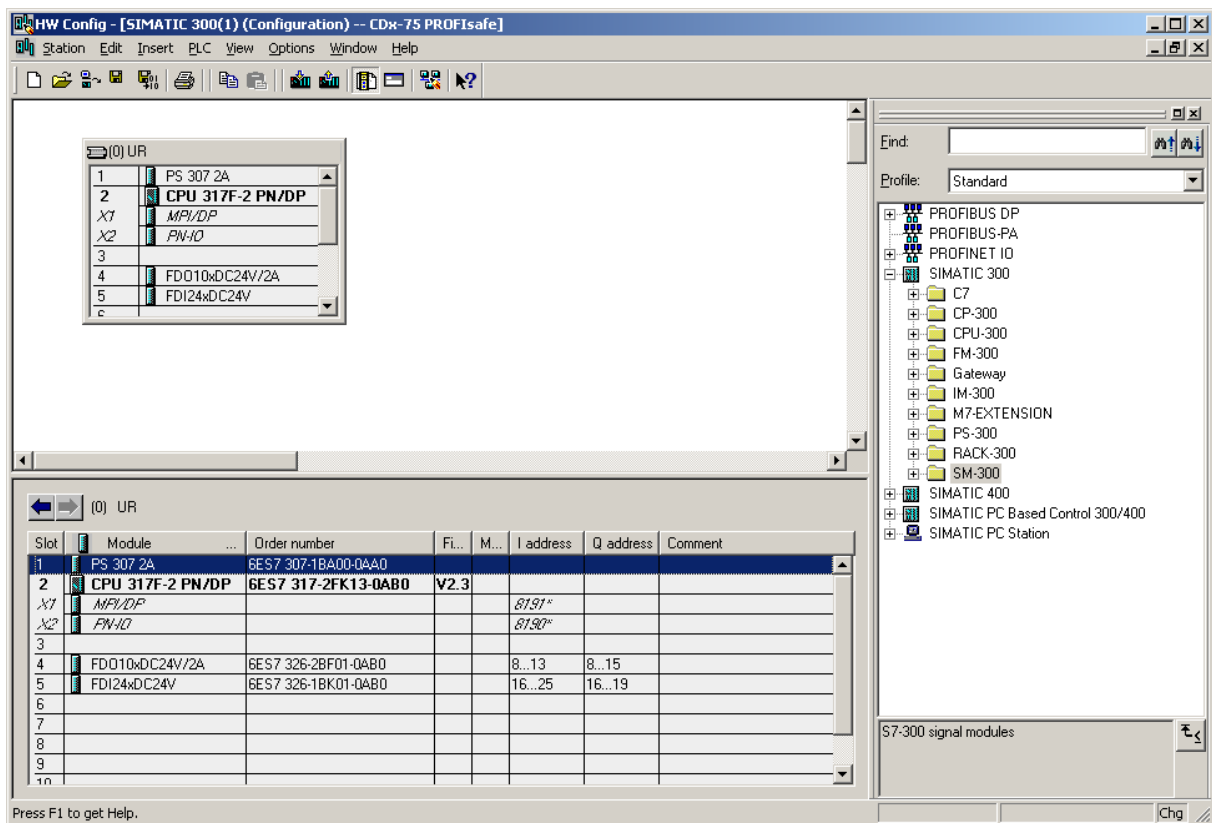
- If the hardware catalog is not shown on the right, it can be displayed with the View --> Catalog menu



- Drag a rail into the project window to take the hardware components



- Drag the power supply PS 307 2A in the catalog to position 1 of the rack with SIMATIC 300 --> PS-300 --> PS 307 2A
- Drag CPU 317F-2 PN/DP in the catalog to position 2 of the rack with SIMATIC 300 --> CPU-300 --> CPU 317F-2 PN/DP --> 6ES7 317-2FK13-0AB0 --> V2.3. Also specify the characteristics of the Ethernet interface here if necessary.
- Drag digital output module SM 326F DO 10xDC24V/2A in the catalog to position 4 of the rack with SIMATIC 300 --> SM-300 --> DO-300 --> SM 326F DO 10xDC24V/2A (6ES7 326-2BF01-0AB0)
- Drag digital input module SM 326F DI 24xDC24V in the catalog to position 5 of the rack with SIMATIC 300 --> SM-300 --> DI-300 --> SM 326F DI 24xDC24V (6ES7 326-1BK01-0AB0)

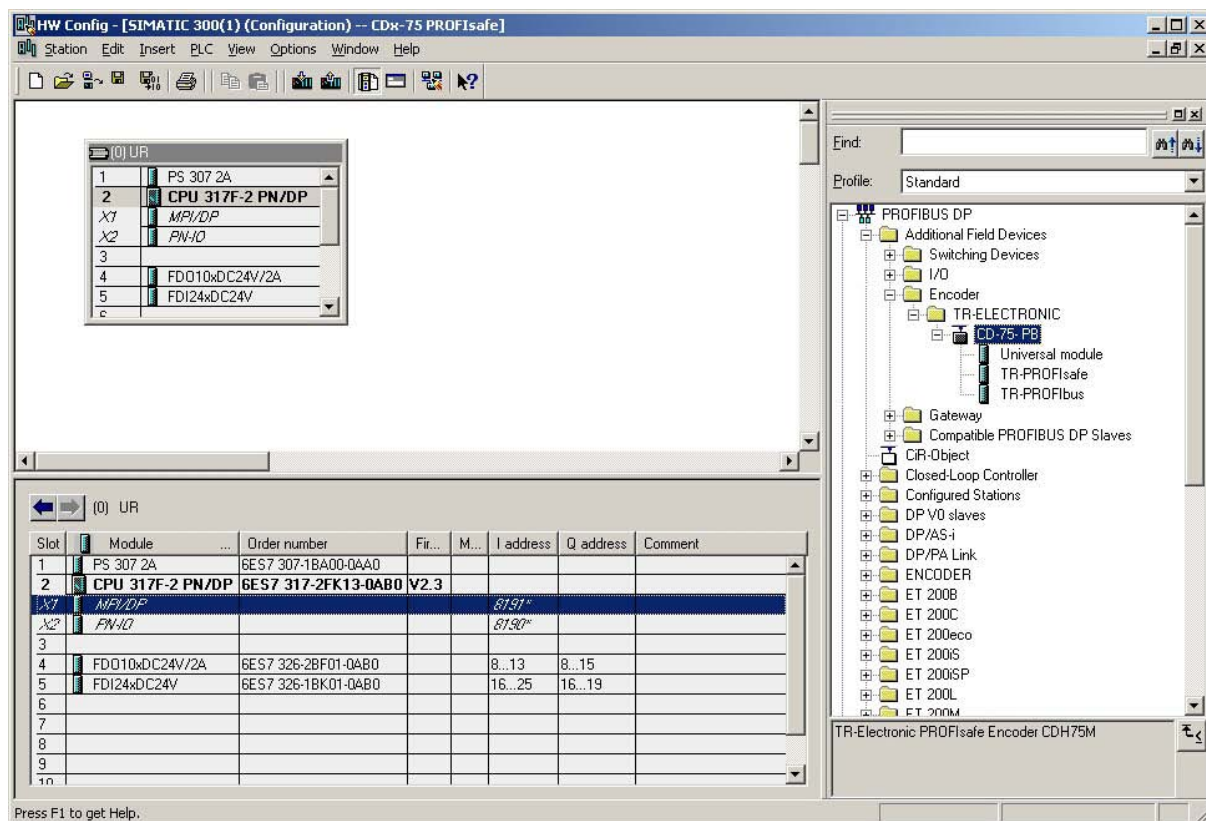


The hardware components to be included in the rack are now complete.

The GSD file TR000CE3.GSE belonging to the measuring system must be installed in the next step. This is copied into the installation directory of the SIMATIC Manager: ...\\S7DATA\\GSD. The bitmap file TR0E_BDE.bmp belonging to the measuring system is copied into the following folder: ...\\S7DATA\\NSBMP. You should note that the directory structure can vary.

- Install GSD file TR000CE3.GSE in the stored directory with menu Options --> Install GSD File....

The measuring system now appears in the catalog as a new item:
PROFIBUS DP --> Additional Field Devices --> Encoder --> TR-
Electronic --> CDH75M-PB



The individual configuration options are shown under this item:

- TR-PROFIsafe, see page 146
- TR-PROFibus, see page 152

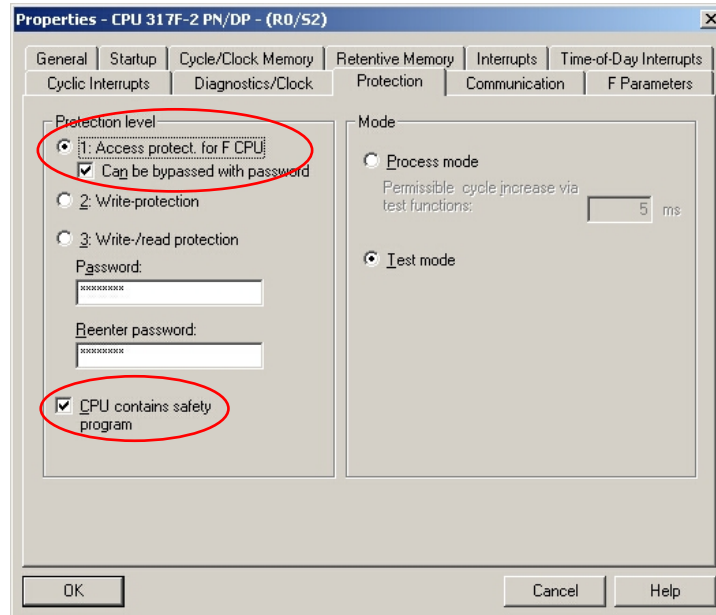


*The item **Universal module** is erroneously provided automatically by some systems, but must not be used!*

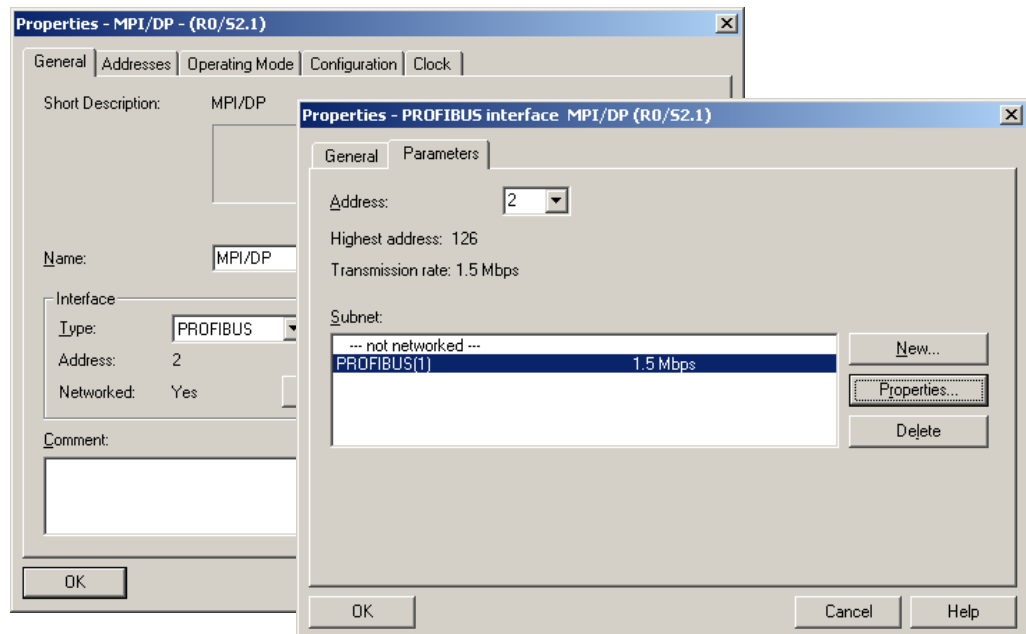
8.2.1 Defining the properties of the hardware configuration

The object properties of the individual hardware components are defined by clicking with the right mouse button on the relevant position in the rack or slot:

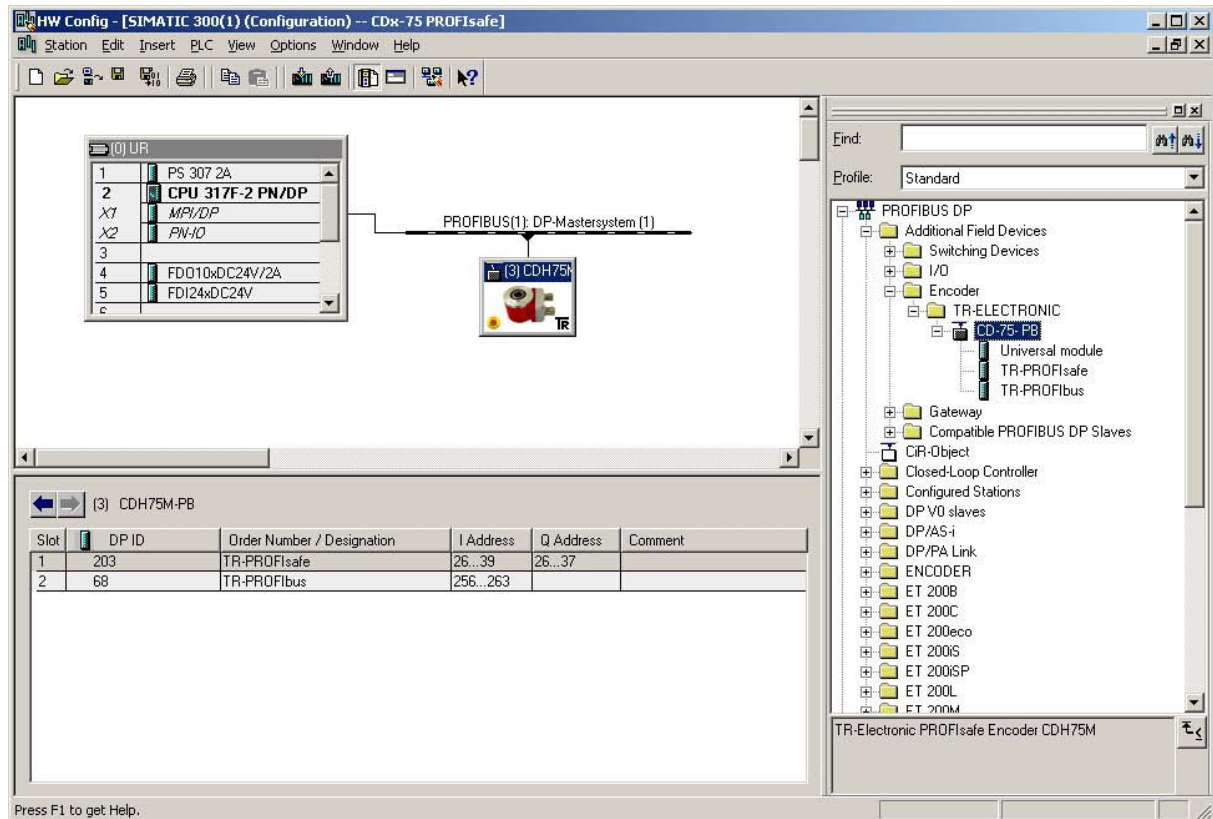
- For the CPU, Protection level 1 and a Password must be configured in the Protection register. The Mode field is not relevant for safety mode.



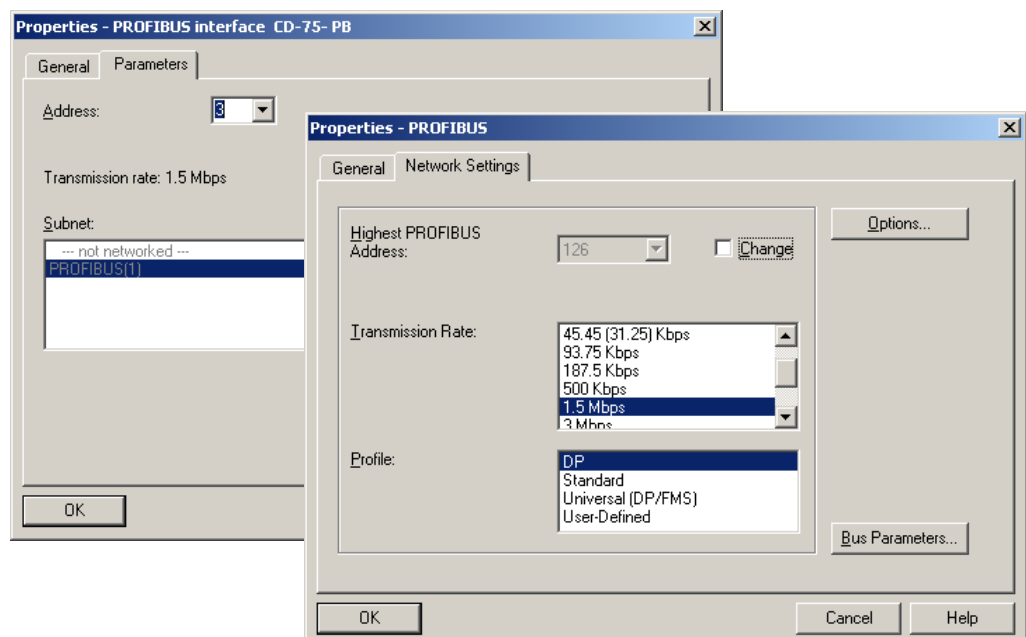
- For the CPU, in the sub-item MPI/DP, General --> register, select PROFIBUS type in the Interface field.
- In the Properties window of PROFIBUS interface MPI/DP, configure the transmission rate 1.5 Mbps



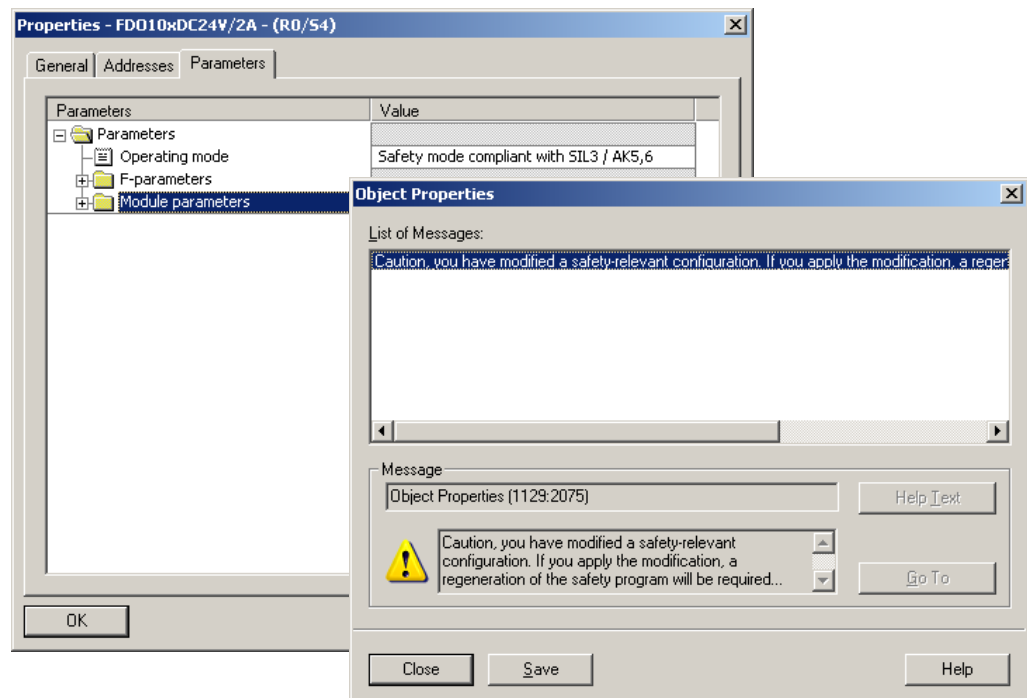
- Connect the CDH75M-PB measuring system from the catalog to the DP master system, to the bus line now available, using Drag&Drop



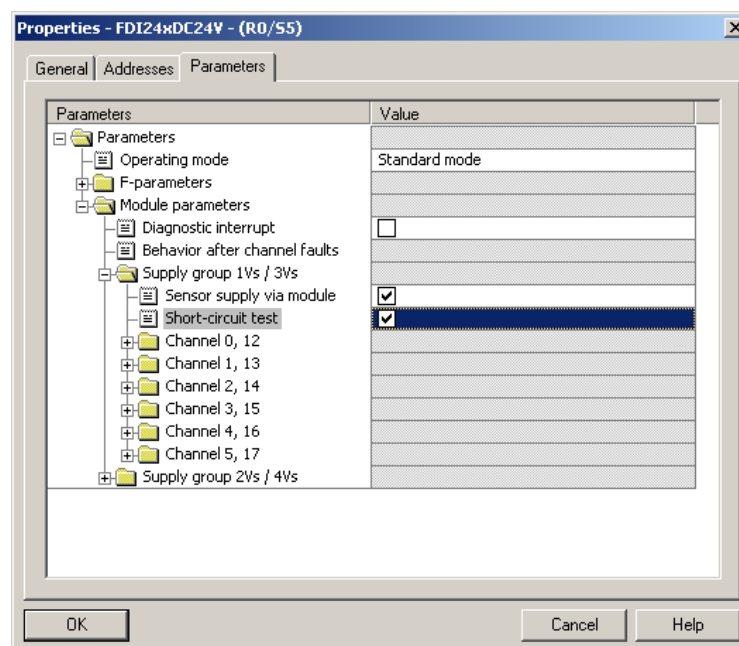
- With connection of the measuring system to the master system, in the Properties window of PROFIBUS interface CDH75M-PB, in the Parameters register, you can now configure the desired Address.
- With the switch Properties... --> Register Network Settings select the desired transmission rate (1.5 Mbps) and enter DP for the Profile.



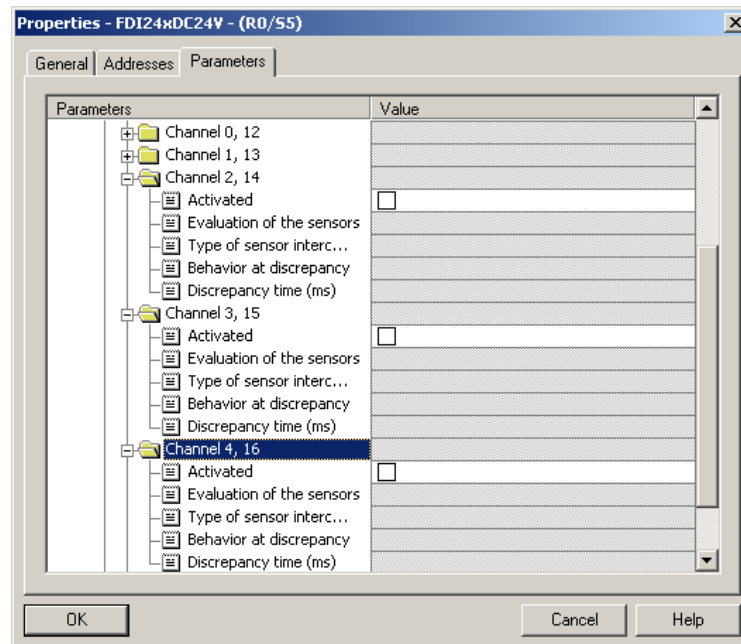
- For the digital output module, in the Parameters register configure Operating mode --> Safety mode compliant with SIL3/AK5,6 and confirm the following window with Close



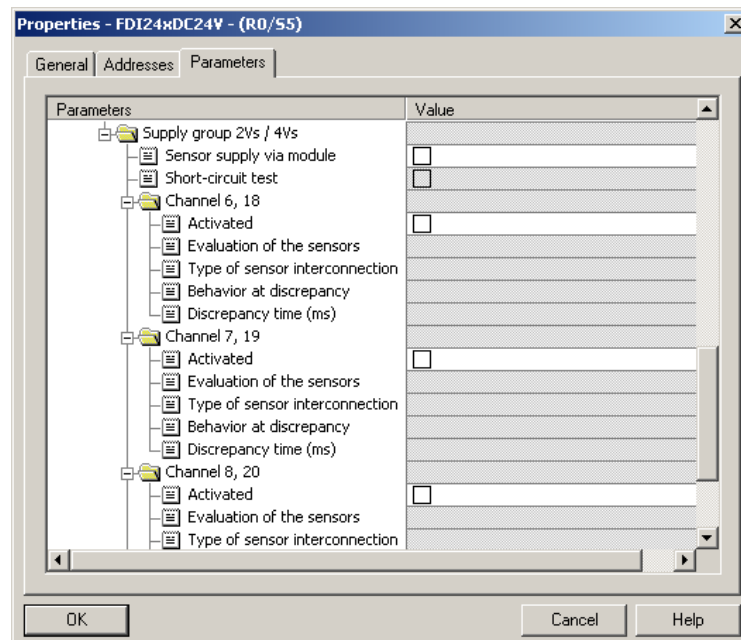
- For the digital input module, in the Parameters register in folder structure Parameters --> Module parameters --> Supply group 1Vs/3Vs, put a tick in the items Sensor supply via module and Short-circuit test



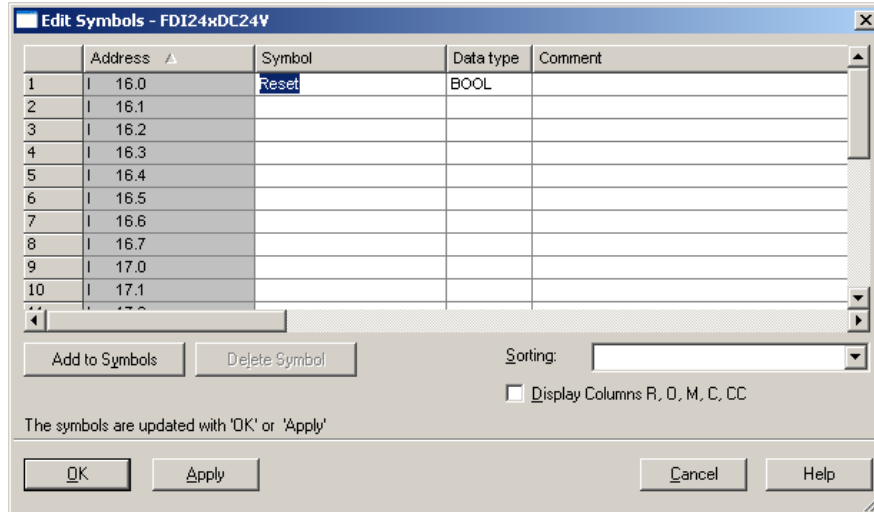
- The settings for channels 0, 12 and 1, 13 remain unchanged.
For channels 2, 14 / 3, 15 / 4, 16 and 5, 17, the tick must be removed under Activated



- In the sub-folder Supply group 2Vs/4Vs, for all channels 6, 18 / 7, 19 / 8, 20 / 9, 21 / 10, 22 and 11, 23 the tick must also be removed under Activated



- For reintegration of the F-Periphery, a RESET symbol is required for the digital input I 16.0. To do this, click with the right mouse button on the item FDI24xDC24V in the rack or slot and select Edit Symbols.... In the Symbol column enter the symbol name Reset, the data type BOOL will then be applied automatically. Press OK to update.



	Address ▲	Symbol	Data type	Comment
1	I 16.0	Reset	BOOL	
2	I 16.1			
3	I 16.2			
4	I 16.3			
5	I 16.4			
6	I 16.5			
7	I 16.6			
8	I 16.7			
9	I 17.0			
10	I 17.1			

Add to Symbols Delete Symbol Sorting:

☐ Display Columns R, O, M, C, CC

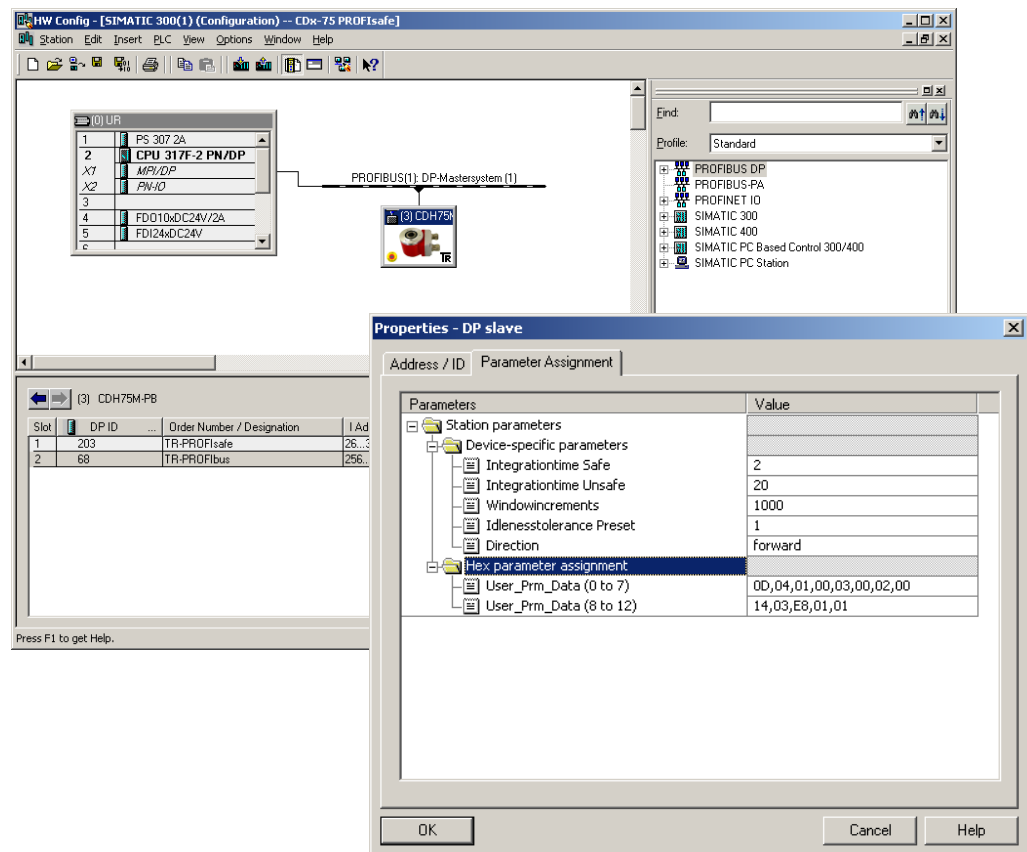
The symbols are updated with 'OK' or 'Apply'

OK Apply Cancel Help

8.3 Parameterization

8.3.1 Setting the iParameters

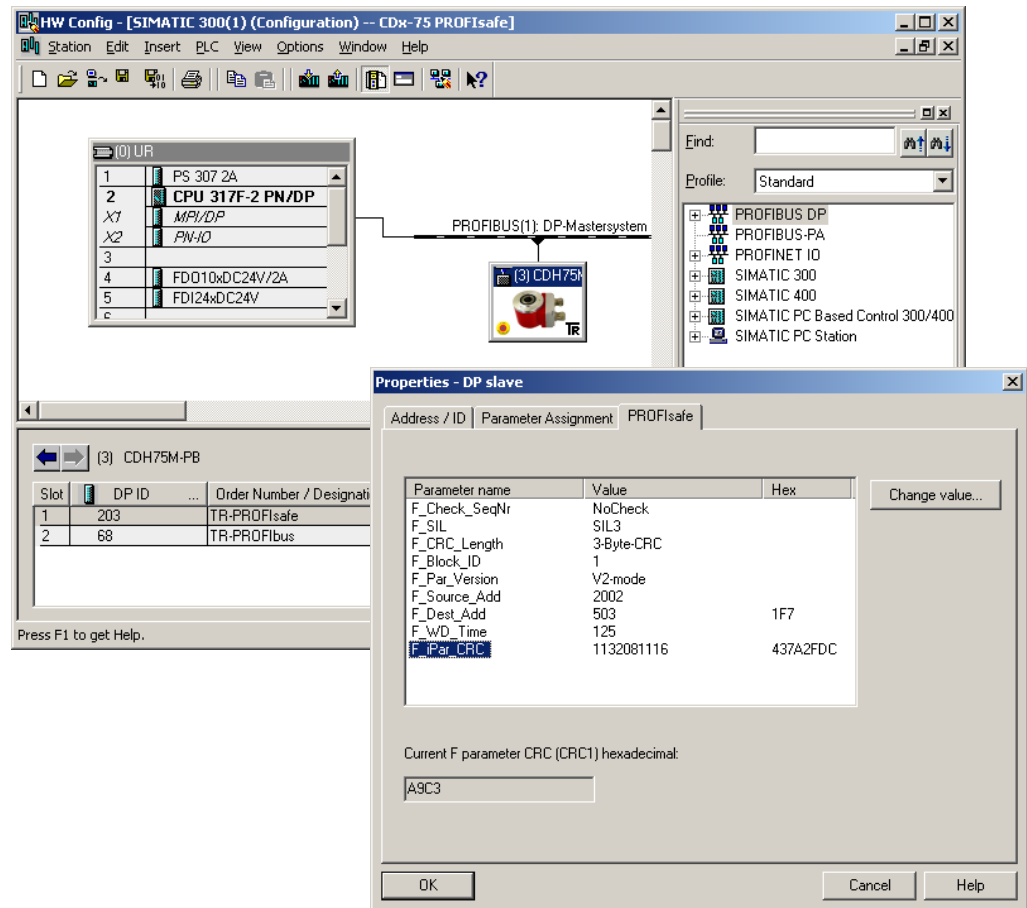
- The iParameters can be set by selecting the Symbol for the measuring system --> Double click on the slot item TR-PROFibus --> Select the Parameter Assignment register



If different parameter values are required, as shown above, a F_iPar_CRC calculation must occur for this new parameter data set, see chapter "Parameter Definition / CRC Calculation" on page 159. The calculated value must then be entered in the parameter data set for the F-Parameters under F_iPar_CRC, see chapter "Setting the F-Parameters" on page 175.

8.3.2 Setting the F-Parameters

- The F-Parameters can be set by selecting the Symbol for the measuring system
--> Double-click on the slot item TR-PROFIsafe --> Select the PROFIsafe register



The parameter value for the parameter F_iPar_CRC results from the set parameter data set for the iParameters and the calculated CRC value, see chapter "Setting the iParameters" on page 174.

The hardware projection is now complete. To enable automatic generation of the safety program, the hardware configuration must now be compiled via the menu Station --> Save and Compile.

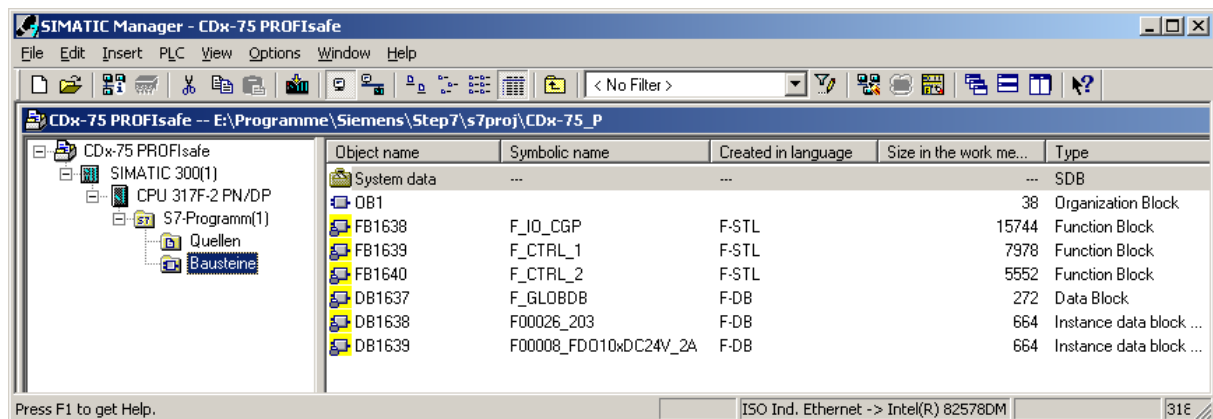
The HW Config can now be closed.

8.4 Creating the missing (F-)blocks

The blocks that have already been automatically created can be viewed in the project folder of the SIMATIC Manager under:

CDx-75 PROFIsafe --> SIMATIC 300(1) --> CPU 317F-2 PN/DP --> S7 Program(1) --> Blocks

All fail-safe blocks are shown with a yellow background to distinguish them from blocks of the standard user program.



8.4.1 Program structure

The safety program is accessed by calling up the F-CALL from the standard user program. The F-CALL is called up directly e.g. in the cyclic interrupt OB 35.

Cyclic interrupt OBs have the advantage that they interrupt the cyclic program processing in OB 1 of the standard user program at fixed time intervals, i.e. in a cyclic interrupt OB the safety program is called up and processed at fixed time intervals.

After the safety program has been processed, the standard user program is further processed.

8.4.2 F-Runtime Group

To facilitate handling, the safety program consists of an "F-Runtime Group". The F-Runtime Group is a logic construct consisting of a number of related F-Blocks, which is formed internally by the F-System.

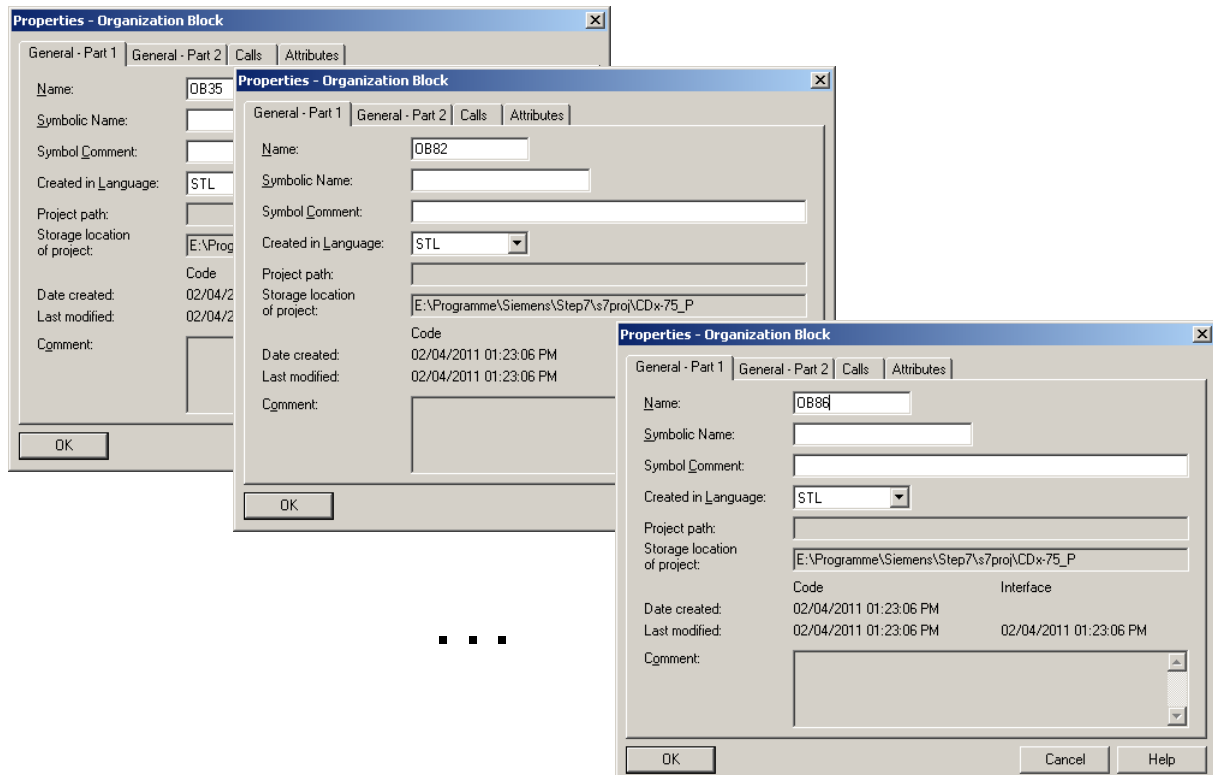
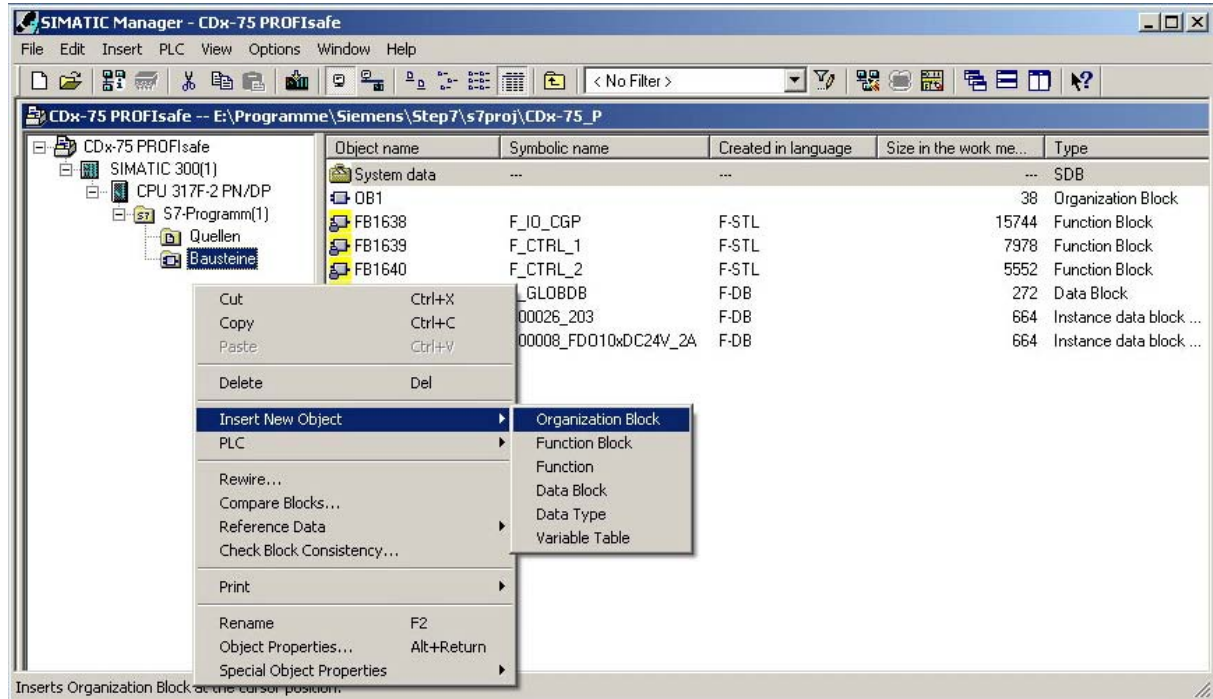
The F-Runtime Group comprises:

- one F-Call block F-CALL, "FC1"
- one F-Program block, to which the F-CALL is assigned, "FC2"
- further F-FBs
- several F-DBs
- F-Periphery-DBs
- F-System blocks F-SBs
- automatically generated F-Blocks

8.4.3 Generating the Object Blocks (OBs)

The necessary Organization Blocks OB35 and OB82 to OB86 are created below.

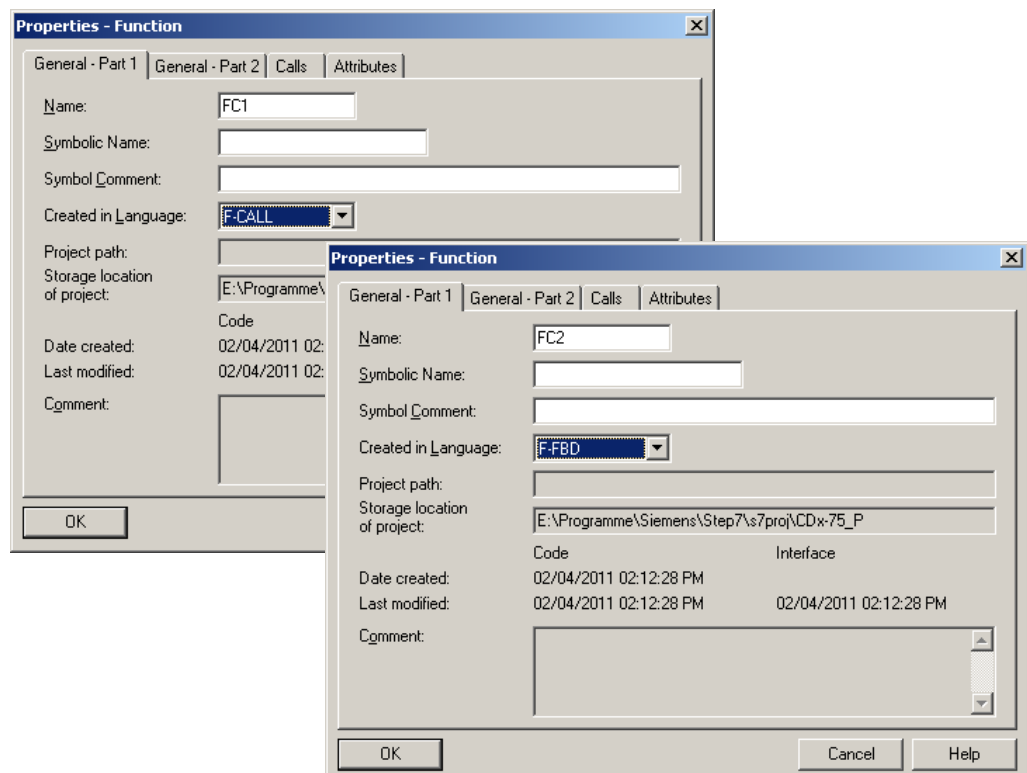
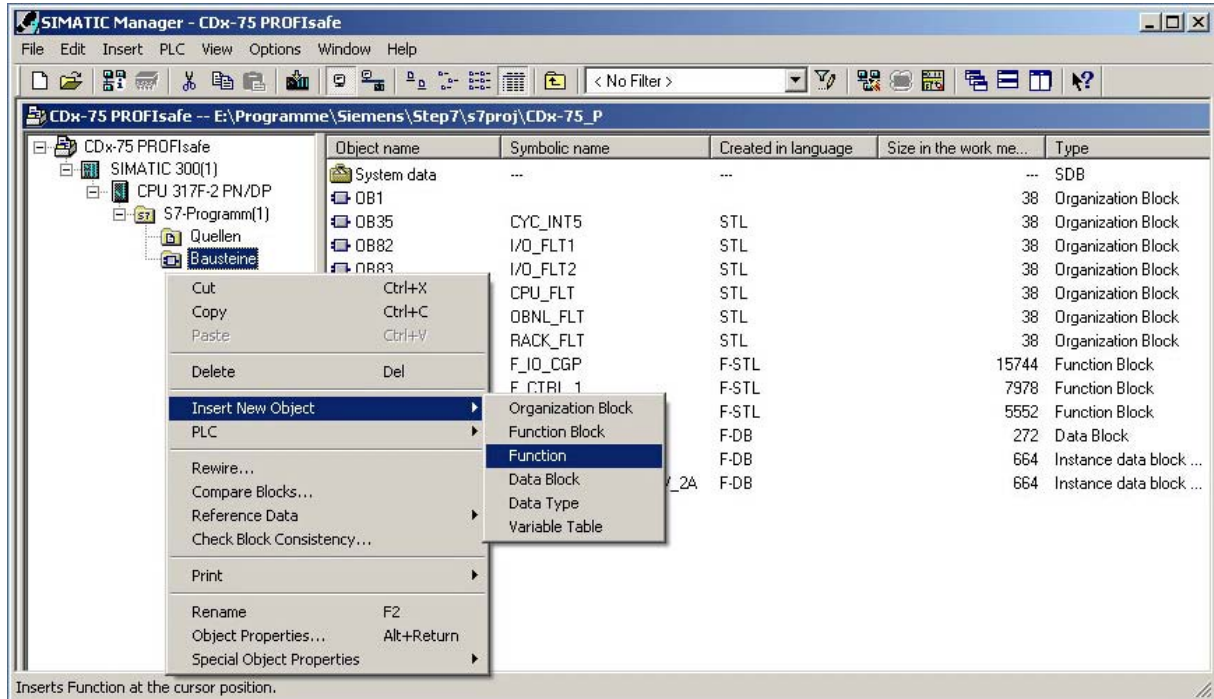
- The Organization Blocks are inserted with the right mouse button in the project window Insert New Object --> Organization Block
The programming language is STL for all Organization Blocks



8.4.4 Generating the functions (F-FCs)

The necessary functions FC1 and FC2 are created below.

- The functions are inserted with the right mouse button in the project window
Insert New Object --> Function
- The programming language for FC1 is F-CALL, for FC2 F-FBD



8.4.5 Programming the F-Blocks

The programming and modifications for blocks OB35, FC1 and FC2 are carried out below.

- The safety program is called up in OB35 by double-clicking on the object name OB35 in the project window. The instruction CALL FC1 must be entered in the open LAD/STL/FBD program window. Finally save the item and close the window again.

OB35 : "Cyclic Interrupt"

Comment:

Network 1: Title:

Comment:

CALL FC 1

For user acknowledgement for reintegration of the F-Periphery after the elimination of errors, the variable ACK_REI of the F-Periphery-DB must be interconnected to the digital input I 16.0 RESET of the digital input module. The function FC2 must be programmed accordingly for this purpose.

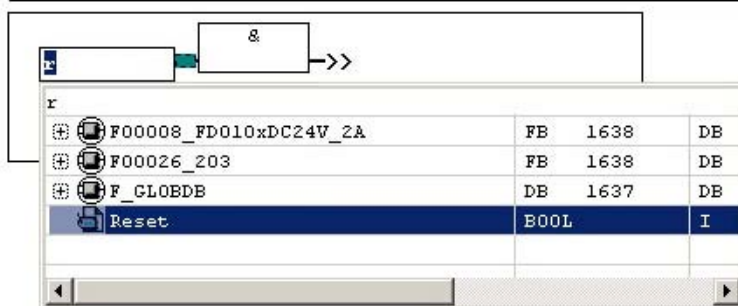
- An And Box is inserted from the tool bar, one input is deleted and the Reset symbol is assigned to the second input

FC2 : Title:

Comment:

Network 1: 1 = Acknowledgement for re-integration

Comment:



The screenshot shows a network with an AND gate (represented by a box with '&') and a variable selection table. The table lists the following variables:

Variable	Address	Type
F00008_FD010xDC24V_2A	FB 1638	DB
F00026_203	FB 1638	DB
F_GLOBDB	DB 1637	DB
Reset	BOOL	I

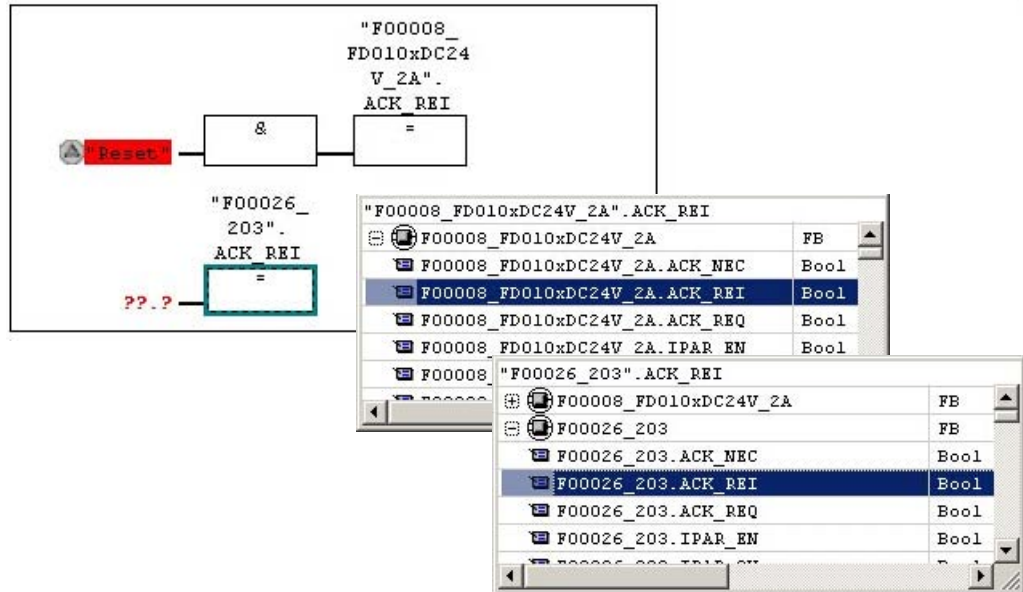
- Two Assignments are inserted from the tool bar, the variable "F00008...".ACK_REI is assigned to one assignment, and the variable "F00026...".ACK_REI to the other.

FC2 : Title:

Comment:

Network 1: 1 = Acknowledgement for re-integration

Comment:



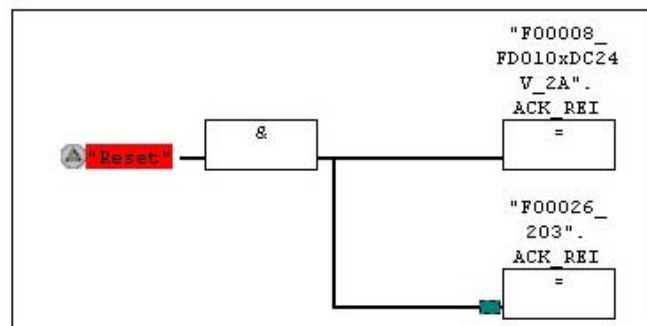
- Finally, the Assignment not yet interconnected is interconnected to the output of the And Box by a Branch. Save the programming and close the window.

FC2 : Title:

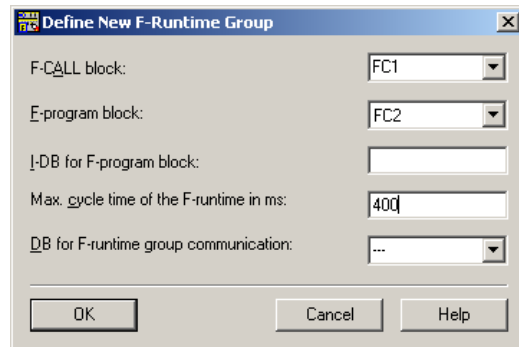
Comment:

Network 1: 1 = Acknowledgement for re-integration

Comment:



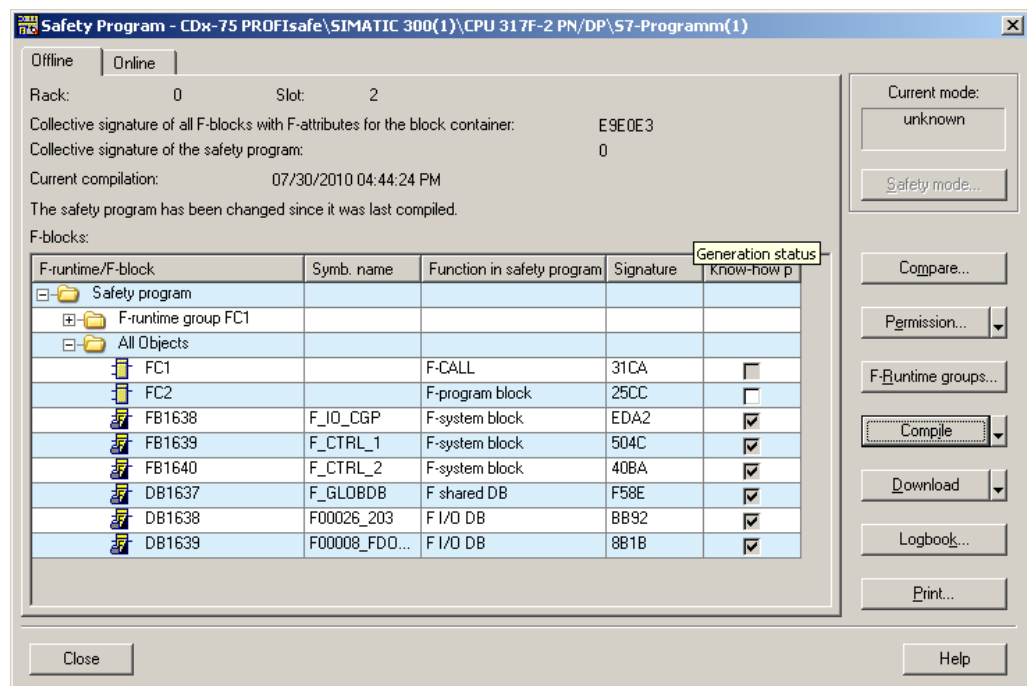
- The Runtime Group is defined with the function FC1. In the field Max. cycle time of the F-runtime in ms: enter the value 400 and confirm with OK. Also confirm the next window Edit F-Runtime Groups with OK.



The programming and modifications are now complete.

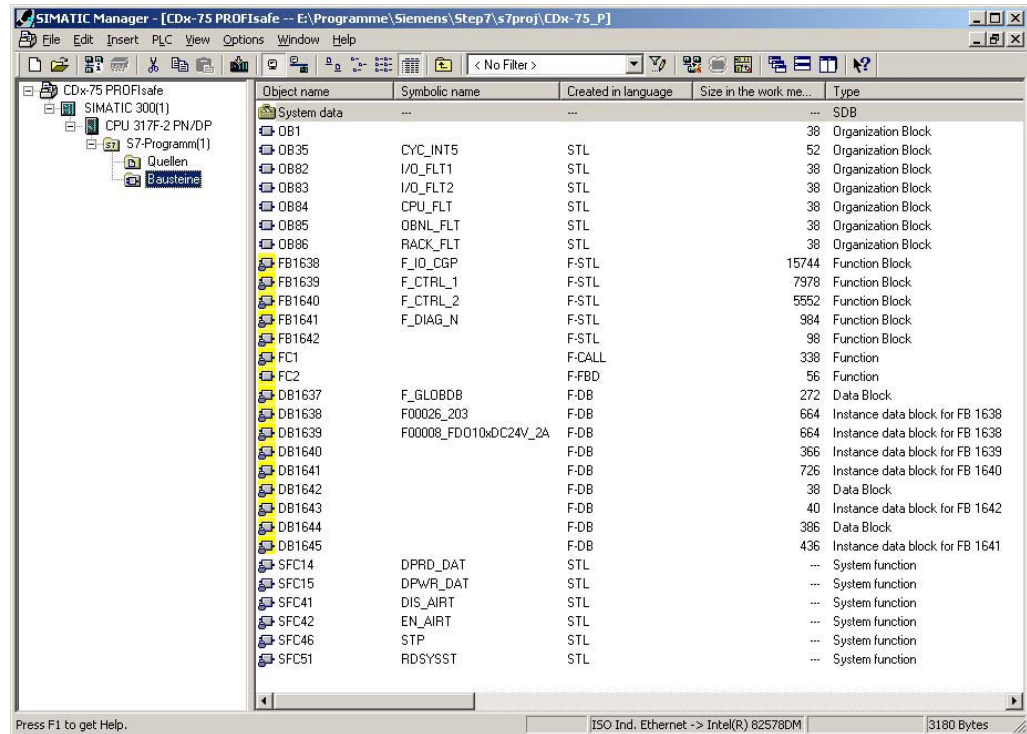
8.5 Generating the safety program

To generate the safety program, in SIMATIC Manager, Options --> Edit safety program menu, open the Safety Program dialog. The safety program is compiled and generated with the Compile switch.



If compilation is successful 0 warnings are displayed, and the windows can then be closed.

All necessary blocks are now displayed in the project window:



8.6 Loading the safety program

When the safety program has been generated, it can be loaded into the F-CPU. It is advisable to transfer the complete safety program to the F-CPU in STOP operating status. This guarantees that a consistent safety program is loaded. The program is loaded with the menu Options --> Edit safety program --> Download switch.

8.7 Testing the safety program

After generating the safety program, a complete functional test must be carried out according to the automation task.

After modifications to an already completely function-tested safety program, it is sufficient to test the modifications.

9 Access to the safety-oriented data channel

The safety-oriented data channel in the TR-PROFIsafe module is accessed via the process image, as with a standard periphery. However, direct access is not permitted. The safety-oriented data channel of the measuring system may only be accessed from the generated F-Runtime Group.

The actual communication between F-CPU (process image) and measuring system for updating the process image occurs concealed in the background, by means of the PROFIsafe protocol.

The measuring system uses a larger area in the process image in the TR-PROFIsafe module, due to the PROFIsafe protocol, than would be necessary for the measuring system function. The F-Parameter-block contained in the process image is not included in the user data. When accessing the process image in the safety program, only access to the pure user data is permitted!

9.1 Output of passivated data (substitute values) in case of error

The safety function requires that for passivation in the safety-oriented channel in the TR-PROFIsafe module, the substitute values (0) are used in the following cases instead of the cyclically output values. This status is indicated via the F-Periphery-DB with PASS_OUT = 1, see below.

- at start-up of the F-System
- in the case of errors in the safety-oriented communication between F-CPU and measuring system via the PROFIsafe protocol
- if the value set for the Window increments under the iParameters is exceeded and/or the internally calculated PROFIsafe telegram is defective
- if the permissible ambient temperature range, as defined under the corresponding article number, is fallen below or exceeded
- if the measuring system is supplied with >36 V DC for longer than 200 ms
- if the measuring system is disconnected in RUN mode, the F-Host is reconfigured and the measuring system is then reconnected

9.2 F-Periphery-DB

For each F-Periphery, measuring system and digital output module, an F-Periphery-DB is automatically generated during compilation in HW Config. With reference to the generated safety program, see chapter "Safety Program Creation - Configuration Example", this is block DB1638 for the measuring system and DB1639 for the digital output module. The F-Periphery-DB contains variables which can be analyzed in the safety program and can or must be written. An exception is the variable DIAG, which may only be analyzed in the standard user program. Modification of the initial/current values of the variables directly in the F-Periphery-DB is not possible, as the F-Periphery-DB is know-how-protected.

The variables of the measuring system F-Periphery-DB must be accessed in the following cases:

- during reintegration of the measuring system after communication errors or after the start-up phase
- during execution of the preset adjustment function
- when analyzing whether passivated or cyclical data are output
- if the cyclical data of the TR-PROFIsafe module are to be passivated depending on defined states of the safety program, e.g. group passivation

9.2.1 Measuring system F-Periphery-DB "DB1638" - Overview of variables

Variable	Data type	Function	Access
PASS_ON	BOOL	1 = Passivation of the cyclical data of the TR-PROFIsafe module via the safety program	read/write
ACK_NEC	BOOL	not supported	–
ACK_REI	BOOL	1 = Acknowledgement for reintegration after communication errors or after the start-up phase	read/write
IPAR_EN	BOOL	Variable for execution of the preset adjustment function	read/write
PASS_OUT	BOOL	Passivation output	read
QBAD	BOOL	1 = Substitute values are output	read
ACK_REQ	BOOL	1 = Acknowledgement request for reintegration	read
IPAR_OK	BOOL	1 = Execution of preset adjustment function successfully completed	read
DIAG	BYTE	Service information, only possible in the standard program	read
QBAD_I_xx	BOOL	1 = Substitute values are output in input channel	read
QBAD_O_xx	BOOL	1 = Substitute values are output in output channel	read

9.2.1.1 PASS_ON

With the variable `PASS_ON = 1` a passivation of the safety-oriented data of the TR-PROFIsafe module can be activated, e.g. depending on defined states in the safety program. The passivation is not performed directly in the measuring system, instead the status of these variables is registered by the F-Host and the passivation is only activated by means of the safety program data. Cyclical data are still output by the measuring system!

If a passivation is performed with `PASS_ON = 1`, the preset adjustment function is switched off.

9.2.1.2 ACK_NEC

Not supported by the measuring system.

9.2.1.3 ACK_REI

If a communication error is detected by the F-System for the measuring system, a passivation of the measuring system is performed.

For reintegration of the measuring system after the elimination of errors a user acknowledgement with positive edge of variable `ACK_REI` of the F-Periphery-DB is required, which is linked to the input of the digital input module

--> I 16.0, symbol name: "RESET"

A user acknowledgement is required:

- after communication errors
- after the start-up phase

An acknowledgement is only possible if the variable `ACK_REQ = 1`.

An user acknowledgement must be provided for each F-Periphery in the safety program via the variable `ACK_REI`. This requirement has already been taken into account for the measuring system and digital output module.

9.2.1.4 IPAR_EN

The variable `IPAR_EN` is used to execute the preset adjustment function. The process sequence for execution of this function is described in chapter "Preset Adjustment Function" on page 189.

A precise description of when the variables must be set/reset during a re-parameterization of fail-safe DP standard slaves/IO standard devices can be found in the *PROFIsafe Specification* from V1.20, or the documentation on the fail-safe *DP Standard Slave/IO Standard Device*.



No passivation of the measuring system is triggered by `IPAR_EN = 1`!

With reference to the preset execution, the warning note contained in the chapter "Preset Adjustment Function" on page 189 must be observed!

9.2.1.5 PASS_OUT/QBAD/QBAD_I_xx/QBAD_O_xx

The variables PASS_OUT = 1 and QBAD = 1 indicate that a passivation of the measuring system is present.

The F-System sets PASS_OUT, QBAD, QBAD_I_xx and QBAD_O_xx = 1, while the measuring system outputs substitute values (0) instead of cyclical values.

If a passivation is performed via the variable PASS_ON = 1, only QBAD, QBAD_I_xx and QBAD_O_xx = 1 are set. However PASS_OUT does not change its value for a passivation via PASS_ON = 1. PASS_OUT can therefore be used for the group passivation of further F-Peripherals.

9.2.1.6 ACK_REQ

If a communication error is detected by the F-System for the measuring system, a passivation of the measuring system is performed. ACK_REQ = 1 indicates that a user acknowledgement is required for reintegration of the measuring system.

The F-System sets the variable ACK_REQ = 1 as soon as the error has been eliminated and a user acknowledgement is possible. After the acknowledgement the variable ACK_REQ is reset to 0 by the F-System.

9.2.1.7 IPAR_OK

The variable IPAR_OK is used to indicate successful execution of the preset adjustment function. The process sequence for execution of this function is described in chapter "Preset Adjustment Function" on page 189.

A precise description of how the variable can be analyzed in the event of a re-parameterization of fail-safe DP standard slaves/IO standard devices can be found in the *PROFIsafe Specification* from V1.20, or the documentation on the fail-safe *DP Standard Slave/IO Standard Device*.

9.2.1.8 DIAG

The DIAG variable provides non-fail-safe information of 1 byte on errors that have occurred, for service purposes. Access to this variable in the safety program is not permitted!

The coding and use of this variable can be found in the SIEMENS manual **S7 Distributed Safety - Configuring and Programming**, document order number: **A5E00109537-04**.

9.3 Access to variables of the F-Periphery-DB

For each F-Periphery, measuring system and digital output module, an F-Periphery-DB is generated automatically during compilation in HW Config and a symbolic name is entered in the symbol table at the same time.

The symbolic name is formed from the fixed prefix "F", the initial address of the F-Periphery and the name entered for the F-Periphery in HW Config in the Object Properties, max. 17 characters.

Variables of the F-Periphery-DB of an F-Periphery may only be accessed from an F-Runtime Group and only from the F-Runtime Group from which the channels of this F-Periphery are accessed, when access is available.

The variables of the F-Periphery-DB can be accessed by specifying the symbolic name of the F-Periphery-DB and the name of the variable: "fully qualified DB access". It must be ensured in SIMATIC Manager, that in the FBD/LAD Editor in the menu Options --> Customize in the General register the option "Report cross-accesses as error" is not activated. Otherwise access to variables of the F-Periphery-DB will not be possible.

9.4 Passivation and reintegration of the measuring system

9.4.1 After start-up of the F-System

After a start-up of the F-System, the communication between F-CPU and measuring system via the PROFIsafe protocol must first be established. A passivation of the measuring system occurs during this time.

During use of the substitute values (0), the variables QBAD, PASS_OUT, QBAD_I_xx and QBAD_O_xx = 1.

The reintegration of the measuring system, i.e. the output of cyclical data at the fail-safe outputs, automatically occurs, from the viewpoint of the F-Host, independently of the setting at the ACK_NEC variable, at the earliest from the 2nd cycle of the F-Runtime Group after start-up of the F-System. Depending on the cycle time of the F-Runtime Group and the PROFIBUS-DP, the reintegration can only occur after a few cycles of the F-Runtime Group.

If the establishment of communication between F-CPU and measuring system takes longer than the monitoring time set in HW Config in the Object Properties for the F-Periphery, no automatic reintegration occurs.

In this case a user acknowledgement with positive edge of variable ACK_REI of the F-Periphery-DB is required, which is linked to the input of the digital input module --> I 16.0, symbol name: "RESET"

9.4.2 After communication errors

If the F-System detects an error in the safety-oriented communication between the F-CPU and measuring system via the PROFIsafe protocol, a passivation of the measuring system occurs.

During use of the substitute values (0), the variables QBAD, PASS_OUT, QBAD_I_xx and QBAD_O_xx = 1.

The reintegration of the measuring system, i.e. the output of cyclical data at the fail-safe outputs, only occurs if:

- no further communication errors are present, and the F-System has set the variable ACK_REQ = 1
- a user acknowledgement with positive edge of variable ACK_REI of the F-Periphery-DB has occurred, which is linked to the input of the digital input module --> I 16.0, symbol name: "RESET"

10 Preset Adjustment Function

⚠ WARNING**NOTICE**

- **Danger of death, serious physical injury and/or damage to property due to uncontrolled start-up of the drive system during execution of the preset adjustment function!**
 - The relevant drive systems must be locked to prevent automatic start-up
 - It is advisable to protect the preset triggering via the F-Host by means of additional protective measures, such as e.g. key-operated switch, password etc.
 - The new position must be checked after execution of the preset function
-

The preset adjustment function is used to set the currently output position value to any position value within the measuring range. The displayed position can thus be set to a machine reference position purely electronically.

The execution of the preset adjustment function is a critical process, as the resulting actual value jump, e.g. when using a controller, could cause uncontrolled machine movements. The preset adjustment function may therefore only be executed when the relevant system part is at a safe standstill.

After completion of the preset process, you must check that the position output by the measuring system matches the position transmitted to the measuring system.

The preset adjustment function is already locked in the measuring system and can only be activated via the variable IPAR_EN in the F-Periphery-DB DB1638. Even if all preconditions are fulfilled from the viewpoint of the F-Host, the preset adjustment function is only executed when the shaft of the measuring system is stationary. However, a certain edge jitter, e.g. caused by machine vibrations, is permitted within a certain tolerance window. This tolerance window can be set with the iParameter Idleness tolerance Preset, see chapter "Idleness tolerance Preset" on page 157.

10.1 Procedure

- Prerequisite: The measuring system is in cyclical data exchange.
- Write the Preset Multi-Turn and Preset Single-Turn registers in the output data of the TR-PROFIsafe module with the desired preset value.
- The F-Host must set the variable IPAR_EN in the F-Periphery-DB to 1. With the rising edge, the measuring system is now switched ready to receive.
- With the rising edge of Bit 2⁰ Preset_Request in the TR-Control1 register, the preset value is accepted. The receipt of the preset value is acknowledged in the TR-Status register by setting Bit 2⁰ Preset_Status.
- After receipt of the preset value, the measuring system checks that all prerequisites for execution of the preset adjustment function are fulfilled. If so, the preset value is written as the new position value. In case of error, the execution is rejected and an error message is output via the TR-Status register by setting Bit 2¹⁵ Error.
- After successful execution of the preset adjustment function, the measuring system sets the variable iPar_OK = 1 in the F-Periphery-DB and thus indicates to the F-Host that the preset execution is complete.
- The F-Host must now reset the variable IPAR_EN in the F-Periphery-DB to 0. The variable iPar_OK and Bit 2⁰ Preset_Status in the TR-Status register are thus also reset with the falling edge. Bit 2⁰ Preset_Request in the TR-Control1 register must be reset manually again.
- Finally, the F-Host must check that the new position corresponds to the new nominal position.

11 Troubleshooting and Diagnosis Options

11.1 Optical displays

For assignment and position of the status LEDs see chapter "Bus status display" on page 145.

11.1.1 LED, green

Green LED	Cause	Remedy
Off	Power supply absent	Check power supply, wiring
	Hardware error, measuring system defective	Replace measuring system
3x 5 Hz repeating	– Measuring system could not synchronize with the F-Host in the start-up phase and requests a reintegration – An error in the safety-oriented communication or a parameterization error was detected, and has been eliminated	For reintegration of the measuring system a user acknowledgement with positive edge of variable ACK_REI of the F-Periphery-DB is required, see chapter "Passivation and reintegration of the measuring system" on page 188
1 Hz	F-Parameterization defective, e.g. incorrectly set PROFIsafe destination address F_Dest_Add	– Check PROFIBUS address set with the hardware switch. The address set here gives the necessary PROFIsafe destination address + 500, see chapter "Bus addressing" on page 136 – Synchronize required safety class F_SIL of system and measuring system, see chapter "F_SIL" on page 155
on	Measuring system ready for operation, connection established with PROFIBUS master	–

11.1.2 LED, red

Red LED	Cause	Remedy
Off	No error	–
1 Hz	– No connection to PROFIBUS master – PROFIBUS address incorrectly set – Incorrectly configured F_iPar_CRC value	– The PROFIBUS address set with the hardware switch must match the projected PROFIBUS address – The checksum calculated for the defined iParameter set is incorrect, or was not included in the projection, see chapter "Parameter Definition / CRC Calculation" on page 159
on	A safety-relevant error was detected, the measuring system was put into fail-safe status and is outputting its passivated data:	In order to restart the measuring system after a passivation the error must generally be eliminated first of all and then the supply voltage switched OFF/ON.
	– Error in the safety-oriented communication	– Try to localize the error with the aid of the DIAG variable, see chapter "DIAG" on page 186 – Check that the set value for the F_WD_Time parameter is suitable for the automation task, see chapter "F_WD_Time" on page 155 – Check whether the PROFIBUS connection between F-CPU and measuring system is faulty
	– The set value for the Window increments parameter was exceeded	– Check that the set value for the Window increments parameter is suitable for the automation task, see chapter "Window increments" on page 157
	– The permissible ambient temperature range, as defined under the corresponding article number, was fallen below or exceeded	– Suitable measures must be taken to ensure that the permissible ambient temperature range can be observed at all times
	– The measuring system was supplied with >36 V DC for longer than 200 ms	– The measuring system must be shut down immediately and checked in the factory. When sending the measuring system to the factory, the reasons and circumstances relating to the overvoltage must be specified
	– The measuring system was disconnected in RUN mode, the F-Host reconfigured and the measuring system then reconnected	– The configuration must only be transferred to the measuring system in STOP status in the start-up phase
	– The internally calculated PROFIsafe telegram is defective	– Power supply OFF/ON. If the error persists after this measure, the measuring system must be replaced
	– The PROFIBUS address set with the hardware switch was set to "0"	– Valid PROFIBUS addresses: 1 – 99

11.2 Use of the PROFIBUS diagnosis

In a PROFIBUS system, the PROFIBUS masters provide the so-called host system, e.g. a PLC-CPU, with process data. If there is no slave on the bus or it is no longer accessible, or the slave reports a fault itself, the master must notify the host system of the fault in one form or another. There are several possibilities here, whose evaluation is solely decided by the application in the host system.

Generally a host system is not stopped by the failure of just one component on the bus, but must react to the failure in an appropriate way in accordance with the safety regulations. Normally the master firstly provides the host system with a summary diagnosis, which the host system reads cyclically from the master, and through which the user is informed of the state of the individual clients on the bus. If a client is reported defective in the summary diagnosis, the host can request further data from the master (slave diagnosis), which then allows a detailed evaluation of the reasons for the fault. The reports obtained in this way can be generated from the master if the affected slave fails to respond to the master's requests, or they may come directly from the slave if it reports a fault itself. The generation or reading of a diagnosis report between the master and slave takes place automatically and does not need to be programmed by the user.

In addition to the standard diagnosis information, the measuring system provides an extended diagnosis report with module status information.

11.2.1 Standard diagnosis

The DP standard diagnosis is structured as follows. The perspective is always as viewed from the master to the slave.

	Byte no.	Meaning	
standard	Byte 1	Station status 1	General part
	Byte 2	Station status 2	
	Byte 3	Station status 3	
	byte 4	Master address	
	byte 5	Manufacturer's identifier HI byte	
	byte 6	Manufacturer's identifier LO byte	
Extended diagnosis	byte 7	Length (in bytes) of the extended diagnosis including this byte	Device-specific extensions
	Byte 8 to Byte 241 (max)	Further device-specific diagnosis	

11.2.1.1 Station status 1

standard diagnosis byte 1	Bit 7	Master_Lock	Slave has been parameterized from another master (bit is set by the master)
	Bit 6	Parameter_Fault	The parameter telegram last sent has been rejected by the slave
	Bit 5	Invalid_Slave_Response	Is set by the master, if the slave does not respond
	Bit 4	Not_Supported	Slave does not support the requested functions.
	Bit 3	Ext_Diag	Bit = 1 means an extended diagnosis report from the slave is waiting
	Bit 2	Slave_Cfg_Chk_Fault	The configuration identifier(s) sent from the master has (have) been rejected by the slave
	Bit 1	Station_Not_Ready	Slave is not ready to exchange cyclical data
	Bit 0	Station_Non_Existent	The slave has been configured, but is not available on the bus

11.2.1.2 Station status 2

standard diagnosis byte 2	Bit 7	Deactivated	Slave was removed from the poll list from the master
	Bit 6	Reserved	
	Bit 5	Sync_Mode	Is set by the slave after receipt of the SYNC command
	Bit 4	Freeze_Mode	Is set by the slave after receipt of the FREEZE command
	Bit 3	WD_On	The response monitoring of the slave is activated
	Bit 2	Slave_Status	Always set for slaves
	Bit 1	Stat_Diag	Static diagnosis
	Bit 0	Prm_Req	The slave sets this bit if it has to be reparameterized and reconfigured.

11.2.1.3 Station status 3

standard diagnosis byte 3	Bit 7	Ext_Diag_Overflow	Overflow for extended diagnosis
	Bit 6-0	Reserved	

11.2.1.4 Master address

Standard diagnosis byte 4

The slave enters the station address of the master into this byte, after the master has sent a valid parameterization telegram. To ensure correct function on the PROFIBUS it is imperative that, in the case of simultaneous access of several masters, their configuration and parameterization information exactly matches.

11.2.1.5 Manufacturer's identifier

Standard diagnosis byte 5 + 6

The slave enters the manufacturer's ID number into the bytes. This is unique for each device type and is reserved and stored by the PNO. The ID number of the measuring system is 0x0CE3.

11.2.1.6 Length (in bytes) of the extended diagnosis

Standard diagnosis byte 7

If additional diagnosis information is available, the slave enters the number of bytes (including this one) at this point, which still follows in addition to the standard diagnosis.

11.2.2 Extended diagnosis

In addition to the DP standard diagnosis report the measuring system provides an extended diagnosis report which contains the module status:

Status block

Byte 7	Byte 8	Byte 9	Byte 10	Byte 11
Header	Status type	Slot no.	Status-ID	Module status
0x09	0x82	0x__	0x00	0x00 or 0x03

- **Header:**
 - Number of bytes in addition to standard diagnosis, including Byte 7
- **Status type:**
 - Status block with module status
- **Slot no.:**
 - Specification of slot no., which is defective
- **Status-ID:**
 - No further differentiation
- **Module status:**
 - 0x00 = valid data from this module
 - 0x03 = invalid data, missing module

Is reported by the measuring system if a CRC error is present in the F-Parameters or iParameters



Bytes 12 to 15 are intended for service purposes

12 Replacing the Measuring System

The following points must be noted when replacing the measuring system:

- The new measuring system must have the same article number as the measuring system being replaced; any deviations must be expressly clarified with TR-Electronic.
- It must be ensured that the PROFIBUS address set via hardware switch for the new measuring system matches the previous PROFIBUS address.
- If a bus termination was provided for the measuring system being replaced, this must also be provided for the new measuring system.
- The new measuring system must be installed in accordance with the specifications and requirements in chapter "Assembly" on page 126.
- The new measuring system must be connected in accordance with the specifications in chapter "Connection" on page 134.
- As the F-Parameters and iParameters of the measuring system are stored in the safety program of the control, the new measuring system is parameterized with the projected settings in the start-up phase.
- When recommissioning the replaced measuring system, correct functioning must be ensured first of all by means of a protected test run.

13 Checklist

We recommend that you print out and work through the checklist for commissioning, replacing the measuring system and when changing the parameterization of a previously accepted system and store it as part of the overall system documentation.

Documentation reason	Date	Edited	Checked

Sub-item	To note	Can be found under	yes
Present user manual has been read and understood	—	Document no.: TR-ECE-BA-DGB-0079	☐
Check that the measuring system can be used for the present automation task on the basis of the specified safety requirements	- Intended use - Compliance with all technical data	- Chapter Intended use, Page 119 - Chapter Technical Data, Page 199	☐
Fulfillment of the installation requirements defined in the user manual	Safe mechanical fixing of the measuring system and safe positive connection of the driving shaft with the measuring system	Chapter Assembly, Page 126	☐
Requirement for the power supply	The power supply used must meet the requirements of SELV/PELV (IEC 60364-4-41:2005)	Chapter Supply voltage, Page 134	☐
Correct PROFIBUS installation	Observance of the international standards valid for PROFIBUS / PROFIsafe or the directives specified by the PROFIBUS User Organization	- Chapter Installation / Preparation for Commissioning, Page 132 - Chapter PROFIBUS / PROFIsafe - Commissioning, Page 140	☐
System test after commissioning and parameter changes	During commissioning and after each parameter change all affected safety functions must be checked	Chapter Parameterization, Page 154	☐

Continued

Sub-item	To note	Can be found under	yes
Preset Adjustment Function	- The preset adjustment function may only be executed when the affected axis is stationary - It must be ensured that the preset adjustment function cannot be inadvertently triggered - After execution of the preset adjustment function the new position must be checked before restarting	Chapter Preset Adjustment Function, Page 189	☐
Device replacement	- It must be ensured that the new device corresponds to the replaced device - All affected safety functions must be checked	- Chapter Parameterization, Page 154 - Chapter Replacing the Measuring System, Page 196	☐

14 Technical Data

14.1 Safety

Functional safety

DIN EN 61508 Part 1-7:2010 **Safety Integrity Level (SIL):** CL3

EN ISO 13849-1:2008/AC:2009.... **Performance Level (PL):** e

Startup time..... Time between POWER-UP and safe position output
Overall system..... ≤ 5 s

PFH, "High demand" operating mode . $7.88 \cdot 10^{-10}$ 1/h

PFD_{av} (T = 20 a) $6.71 \cdot 10^{-5}$

MTTF_d high 98 a

*** DC_{avg} high**..... 98 %

Internal process safety time..... Time between occurrence of an F-Error and alarm indication
Overall system..... ≤ 10 ms

Process safety angle..... Angle between error occurrence and alarm indication
via channel-internal self-diagnosis .. $\pm 100^\circ$, in relation to the measuring system shaft
Through channel comparison Parameterizable with iParameter
Window increments

Service life..... 20 years

* The assessment occurred in accordance with Note 2 on Table 6 of EN ISO 13849-1

14.2 Electrical characteristics

14.2.1 General

Supply voltage 11...27 V DC acc. to IEC 60364-4-41, SELV/PELV
Feed single feed input, but electrically separated internally
by means of two power supplies
Reverse polarity protection yes
Short-circuit protection yes, by internal 500 mA safety fuse
Overvoltage protection yes, up to ≤ 36 V DC

Current consumption without load < 150 mA at 24 V DC

14.2.2 Device-specific

Total resolution	≤ 28 bit
Number of steps / revolution	≤ 8.192
Number of revolutions	≤ 32.768
Accuracy	13 bit, Single-Turn
Safety principle	2 redundant scanning units with internal triangulation
PROFIBUS-DP V0 interface	IEC 61158, IEC 61784
PROFIsafe profile	3.192b according to IEC 61784-3-3
Additional functions	Preset
* Parameter	
- Integration time Safe.....	50 ms...500 ms
- Integration time Unsafe	5 ms...500 ms
- Size of monitoring window	50...4000 increments
- Idleness tolerance Preset	1...5 increments/Integration time Safe
- Counting direction.....	forward, backward
Transmission	RS485, twisted and shielded copper cable with a single conductor pair (cable type A)
Output code	Binary
Addressing	1 – 99, settable via rotary switch
Baud rate	9.6 kbit/s...12 Mbit/s
* TR-specific functions	Speed output in increments/Integration time Safe
SIN/COS interface	Signals twisted in pairs and shielded
Number of periods.....	4096 / revolution
SIN+, SIN–, COS+, COS–	1 Vss at 100 Ω, differential
Short-circuit proof.....	yes
Incremental interface, alternative	Signals twisted in pairs and shielded
Pulses / revolution	4.096, 8.192, 12.288, 16.384, 20.480, via factory setting
A, /A, B, /B	RS422 (2-wire) according to EIA standard
Output frequency.....	≤ 500 KHz
Cycle time	
Not safety-oriented	0.5 ms, output via TR-PROFIBUS module
Safety-oriented	5 ms, output via TR-PROFIsafe module

* parameterizable via PROFIBUS-DP

14.3 Environmental conditions

Vibration

DIN EN 60068-2-6:2008..... Vibration, sinusoidal

DIN EN 60068-2-64:2009..... Broadband random

Shock

DIN EN 60068-2-27:2010..... Single shock

EMC

Immunity to disturbance EN 61000-6-2:2005

Transient emissions EN 61000-6-3:2007

Working temperature 0 °C...+60 °C

Optional -20 °C...+70 °C with limited functionality

Storage temperature -30 °C...+80 °C, dry

Relative air humidity, DIN EN 60068-3-4:2002 98 %, non-condensing

Protection class, DIN EN 60529: 2000 ¹⁾ IP 54

¹⁾ valid with screwed-on mating connector and/or screwed-on cable gland

14.4 Mechanical characteristics

14.4.1 CDV-75

Mechanically permissible speed..... $\leq 6.000 \text{ min}^{-1}$

Shaft load, at the shaft end $\leq 50 \text{ N}$ axial, $\leq 90 \text{ N}$ radial

Bearing life time..... $\geq 3.9 \cdot 10^{10}$ revolutions at

Speed $\leq 3.000 \text{ min}^{-1}$

Operating temperature $\leq 60 \text{ °C}$

Shaft load, at the shaft end $\leq 50 \text{ N}$ axial, $\leq 90 \text{ N}$ radial

Permissible angular acceleration $\leq 10^4 \text{ rad/s}^2$

Start-up torque at 20 °C typically 0.6 Ncm

Mass..... typically 1 kg

14.4.2 CDH-75

Mechanically permissible speed..... $\leq 3.000 \text{ min}^{-1}$

Shaft load Own mass

Bearing life time..... $\geq 3.9 \cdot 10^{10}$ revolutions at

Speed $\leq 1.500 \text{ min}^{-1}$

Operating temperature $\leq 60 \text{ °C}$

Permissible angular acceleration $\leq 10^4 \text{ rad/s}^2$

Start-up torque at 20 °C typically 6 Ncm

Mass..... typically 1 kg

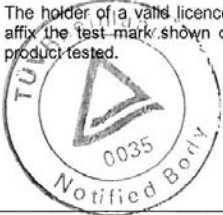
15 Appendix

15.1 Abbreviations and terms used

CDH	Absolute encoder with redundant dual scanning, hollow shaft design
CDV	Absolute encoder with redundant dual scanning, solid shaft design
CDx	Absolute encoder with redundant dual scanning, all designs
CRC	C yclic R edundancy C heck
EC	E uropean C ommunity
EMC	E lectro M agnetic C ompatibilty
ESD	E lectro S tatic D ischarge
IEC	I nternational E lectrotechnical C ommission
VDE	V erein D eutscher E lektrotechniker (Association of German Electrotechnicians)
Engineering tool	Projection and commissioning tool
F	Generally stands for the term safety or fail-safe
F-Device	Safety device for safety applications
F-Host	Safety control for safety applications
Fault exclusion	Compromise between the technical safety requirements and the theoretical possibility of an error occurring
FMEA	F ailure M ode and E ffects A nalysis, reliability engineering methods, for finding potential weak points
Passivation	In the case of an F-Periphery with outputs, the F-System transmits substitute values (e.g. 0) to the fail-safe outputs during a passivation instead of the output values provided in the process image by the safety program.
DC _{avg}	D iagnostic C overage Average diagnostic coverage
PFD _{av}	A verage P robability of F ailure on D emand Average probability of failure of a safety function with low demand
PFH	P robability of F ailure per H our Operating mode with high requirement rate or continuous demand. Probability of dangerous failure per hour.
MTTF _d	M ean T ime T o F ailure (dangerous) Mean time until dangerous failure
SIL	S afety I ntegrity L evel: Four discrete levels (SIL1 to SIL4). The higher the SIL of a safety-related system, the lower the probability that the system cannot execute the required safety functions.

SIS	Safety Instrumented System: is used to protect a dangerous process and reduce the risk of an accident. Process instruments are a constituent of a Safety Instrumented System. This comprises the essential components of a complete safety-relevant process unit: Sensor, fail-safe processing unit (control) and actuator
Functional safety	Part of the overall system safety, which depends on the correct functioning of safety-related systems for risk reduction. Functional safety is ensured when each safety function is executed as specified.
SCS	Safety Computer System with control function, also referred to as F-Host in relation to PROFIsafe
0x	Hexadecimal representation

15.2 TÜV certificate

 TÜVRheinland®			
ZERTIFIKAT CERTIFICATE		EC Type-Examination Certificate Reg.-Nr./No.: 01/205/5015/10	
Prüfgegenstand Product tested	Sicherheits-Drehgeber mit PROFISafe Schnittstelle Safety Rotary Encoder with PROFISafe Interface	Zertifikatsinhaber Certificate holder	TR - Electronic GmbH Eglishalde 6 78647 Trossingen Germany
Typbezeichnung Type designation	CDH 75 M PB, CDV 75 M PB	Hersteller Manufacturer	wie Zertifikatsinhaber see certificate holder
Prüfgrundlagen Codes and standards forming the basis of testing	EN 61800-5-2:2007 EN 62061:2005 EN ISO 13849-1:2008 + AC:2009	IEC 61508 Parts 1-7:2010 EN 50178:1997 EN 60204-1:2006 + A1:2009 (in extracts)	
Bestimmungsgemäße Verwendung Intended application	Die Geräte erfüllen die Anforderungen der Prüfgrundlagen (Kat. 4 / PL e nach EN ISO 13849-1, SIL CL 3 nach EN 61800-5-2 / EN 62061 / IEC 61508) und können in Anwendungen bis Kat. 4 / PL e nach EN ISO 13849-1 und SIL 3 nach EN 62061 / IEC 61508 eingesetzt werden. The devices comply with the requirements of the relevant standards (Cat. 4 / PL e acc. to EN ISO 13849-1, SIL CL 3 acc. to EN 61800-5-2 / EN 62061 / IEC 61508) and can be used in applications up to Cat. 4 / PL e acc. to EN ISO 13849-1 and SIL 3 acc. to EN 62061 / IEC 61508.		
Besondere Bedingungen Specific requirements	Die Hinweise in der zugehörigen Installations- und Betriebsanleitung sind zu beachten. The instructions of the associated Installation and Operating Manual shall be considered.		
Es wird bestätigt, dass der Prüfgegenstand mit den Anforderungen nach Anhang I der Richtlinie 2006/42/EG über Maschinen übereinstimmt. It is confirmed, that the product under test complies with the requirements for machines defined in Annex I of the EC Directive 2006/42/EC.			
Dieses Zertifikat ist gültig bis 10.09.2015. This certificate is valid until 2015-09-10.			
 Functional Safety Type Approved FS		Der Prüfbericht-Nr.: 968/M 271.00/10 vom 10.09.2010 ist Bestandteil dieses Zertifikates. Der Inhaber eines für den Prüfgegenstand gültigen Genehmigungs-Ausweises ist berechtigt, die mit dem Prüfgegenstand übereinstimmenden Erzeugnisse mit dem abgebildeten Prüfzeichen zu versehen. The test report-no.: 968/M 271.00/10 dated 2010-09-10 is an integral part of this certificate. The holder of a valid licence certificate for the product tested is authorized to affix the test mark shown opposite to products, which are identical with the product tested.	
Berlin, 2010-09-10		 Certification Body for Machinery, NB 0035 	

15.3 EC Declaration of Conformity

Expansion in Automation 													
EC Declaration of Conformity													
The Rotative Measuring System CDx75M SIL3 PROFIsafe Type: CDV75M, CDH75M Order-No.: CDV75M-xxxxx, CDH75M-xxxxx was developed, designed and manufactured to comply with the - EC directive 2004/108/EG (L 390/24) "Electromagnetic Compatibility" and - EC directive 2006/42/EG (L 157/24) "Machinery" under the sole responsibility of TR-Electronic GmbH Eglishalde 6 D - 78647 Trossingen Tel.: +49 7425/228-0 Fax: +49 7425/228-33 Germany													
The following harmonized standards were applied: <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">EN 61000-6-2: 2005 (Industrial environments) with increased test standards: DIN IEC 61326-3: 2004</td> <td style="width: 50%; padding: 5px;">Generic standards - Electromagnetic compatibility, Immunity</td> </tr> <tr> <td style="padding: 5px;">EN 61000-6-3: 2007 (Commercial environments)</td> <td style="padding: 5px;">Generic standards - Electromagnetic compatibility, Emissions</td> </tr> <tr> <td style="padding: 5px;">EN 61800-5-2: 2007</td> <td style="padding: 5px;">Adjustable speed electrical power drive systems Safety requirements - Functional</td> </tr> <tr> <td style="padding: 5px;">EN ISO 13849-1: 2008/AC:2009</td> <td style="padding: 5px;">Safety of machinery - Safety-related parts of control systems General principles for design</td> </tr> <tr> <td style="padding: 5px;">EN 60204-1: 2006</td> <td style="padding: 5px;">Safety of machinery - Electrical equipment of machines General requirements</td> </tr> <tr> <td style="padding: 5px;">EN 62061: 2005</td> <td style="padding: 5px;">Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems</td> </tr> </table>		EN 61000-6-2: 2005 (Industrial environments) with increased test standards: DIN IEC 61326-3: 2004	Generic standards - Electromagnetic compatibility, Immunity	EN 61000-6-3: 2007 (Commercial environments)	Generic standards - Electromagnetic compatibility, Emissions	EN 61800-5-2: 2007	Adjustable speed electrical power drive systems Safety requirements - Functional	EN ISO 13849-1: 2008/AC:2009	Safety of machinery - Safety-related parts of control systems General principles for design	EN 60204-1: 2006	Safety of machinery - Electrical equipment of machines General requirements	EN 62061: 2005	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems
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EN 60204-1: 2006	Safety of machinery - Electrical equipment of machines General requirements												
EN 62061: 2005	Safety of machinery - Functional safety of safety-related electrical, electronic and programmable electronic control systems												
Other applied standards: <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%; padding: 5px;">DIN EN 61508 Part 1-7: 2010</td> <td style="width: 50%; padding: 5px;">Functional safety of electrical/electronic/programmable electronic safety-related systems</td> </tr> </table>		DIN EN 61508 Part 1-7: 2010	Functional safety of electrical/electronic/programmable electronic safety-related systems										
DIN EN 61508 Part 1-7: 2010	Functional safety of electrical/electronic/programmable electronic safety-related systems												
The EC type examination and certification according to the EC machinery directive as Logic Unit For Safety Functions was carried out by the notified body: NB0035, TÜV Rheinland Industrie Service GmbH, Alboinstr. 56, 12103 Berlin Certificate-No.: 01/205/5015/10													
Authorized to compile the technical file: TR-Electronic GmbH, Eglishalde 6, 78647 Trossingen, Germany													
Trossingen, 13.08.2010	 Ulrich Schwarz, Engineering Manager												
TR-ECE-KE-DGB-0318-00.DOC													

15.4 Accessories

490-00101		Info
	Switch cabinet module PT-6	TR-V-TI-GB-0020

490-00105		Info
	Switch cabinet module PT-15/2	TR-V-TI-GB-0060

490-01001	
	Software and Support DVD: - GSD, EDS, Type and XML Files + Documentations - Tools - Programming Software - Driver

40803-40005	
	PROFIBUS terminating resistor for M12 flange socket B-coded, 220 Ω

15.5 Drawings